NASA AUTHORIZATION FOR FISCAL YEAR 1961

HEARINGS

BEFORE THE

NASA AUTHORIZATION SUBCOMMITTEE

OF THE

COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES UNITED STATES SENATE

EIGHTY-SIXTH CONGRESS

SECOND SESSION

ON

H.R. 10809

ACT TO AUTHORIZE APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR SALARIES AND EXPENSES, RESEARCH AND DEVELOPMENT, CONSTRUCTION AND EQUIPMENT, AND FOR OTHER PURPOSES

MARCH 28, 29, 30, 1960

PART 1

PROGRAM DETAIL FOR FISCAL YEAR 1961

Printed for the use of the Committee on Aeronautical and Space Sciences

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NASA AUTHORIZATION FOR FISCAL YEAR 1961

MONDAY, MARCH 28, 1960

U.S. SENATE,
SUBCOMMITTEE ON NASA AUTHORIZATION OF THE
COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES,
Washington, D.C.

The subcommittee met, pursuant to call, at 2 p.m., in room 235, Old Senate Office Building, Senator John C. Stennis, chairman of the subcommittee, presiding.

Present: Senators Stennis, Smith, Young, Cannon, and Martin.

Also present: Kenneth E. BeLieu, staff director; Max Lehrer, assistant staff director; Everard H. Smith, Jr., counsel; Mr. William J. Deachma, assistant counsel; Dr. Glen P. Wilson, chief clerk; Dr. Earl W. Lindveit, assistant chief clerk; and Elwyn Darden, assistant to Senator Stennis.

Senator STENNIS. Let the subcommittee come to order, please.

This being an open hearing, if someone at the door could just leave it open for a while so that people who wish to can come in—I think the more people that hear this testimony, the better it will be.

I have a very short statement here, preceding the testimony of the first witness, Dr. Glennan.

OPENING STATEMENT OF SENATOR STENNIS

This afternoon, the subcommittee is starting open hearings on the fiscal year 1961 authorization request for the National Aeronautics and Space Administration.

We have before us for consideration H.R. 10809. As passed by the House, this bill authorizes appropriations for fiscal year 1961 totaling $915 million. That is a step up from last year of approximately $530 million, which shows the enormous growth of this program, as well as its importance.

The full amount requested by the executive branch is $915 million. It is worth noting that the $915 million was actually requested in two installments; the original budget estimates totaled $802 million, but an additional $113 million was requested in the budget amendments transmitted to the Congress on February 8, 1960.

Last year, this subcommittee divided consideration of the NASA authorization request into two separate but interrelated phases. One phase involved detailed consideration of the fundamental scientific and technical aspects of the key aeronautical and space activities planned for the next 5 to 10 years. The second phase involved examination of the specific projects and line items involved in the fiscal year 1960 authorization request.

I believe this procedure worked very well. The scientific and technical hearings gave the committee members and the Congress as a whole a good background against which to evaluate the specific programs for which funds were being requested. In addition, the volume covering the scientific and technical presentations has had a large circulation throughout the country as a primer on our national aeronautical and space programs.

Even though there have been significant changes in a number of the specific projects and line items that were discussed last year, I am advised by the staff that the bulk of the material contained in the volume covering last year's scientific and technical hearings is still valid today. I am pleased to note, Dr. Glennan, that your staff is already working with the committee staff to revise and update this material.

When this task is completed the revised volume of scientific and technical information will be reprinted as part of the hearings on the NASA authorization for fiscal year 1961. I might state the volume of this testimony given by you gentlemen last year has been sold out by the Printing Office, about 1,500 copies already, and the Printing Office wants to reprint it. Those are the copies of the hearings. The committee has distributed about 2,000 copies, and the public has purchased about 1,500 copies from the Government Printing Office.

Our first witness this afternoon will be Dr. T. Keith Glennan, Administrator of the National Aeronautics and Space Administration.

As you know, Dr. Glennan, this committee has consistently pressed for—and has supported efforts toward—a vigorous, imaginative and comprehensive national space program.

We have also been concerned that our space programs be funded in a prudent manner—that every effort be made to avoid any extravagance or costly duplication on the one hand, and the equally undesirable pitfall of being penny wise and pound foolish on the other hand.

You will recall, Dr. Glennan, that this committee asked you last year whether the fiscal year 1960 budget request for NASA was adequate. You told us, in essence, that you did not need additional funds—that the budget request of $530,300,000 was tight but adequate to attain a sound program.

Accordingly, this committee recommended authorization of the exact amount requested and the 1960 NASA authorization was enacted on that basis.

Several weeks later, on July 13, 1959, you testified to the Senate Appropriations Committee as follows:

> As further evidence of our tight belts, I would like to state that we do not have a single backup vehicle for any of our scientific experiments. Each must be a one-shot affair, and if the booster malfunctions, we will simply have to lay the experiment aside.

You were speaking there as the Prophet Jeremiah.

Only a few months later, the Soviet Lunik II hit the Moon with the Soviet coat of arms and then Lunik III triumphantly orbited around and photographed the dark side of the Moon. Our own lunar probe attempt, made on Thanksgiving Day with the Atlas-Able IV, failed.

It was then that we learned, at a tremendous cost in national prestige, the consequences of not planning for adequate backup boosters as insurance for our key space shots.

I am bringing this up to date and reviewing it, because there was some misunderstanding about it. This was well summarized by the following extracts from an Associated Press dispatch that same day:

The failure of a U.S. Moon rocket early Thursday probably means Russia will hold its lead in space exploration for another year.

* * * * * * *

The United States does not have a second vehicle ready to take advantage of the Moon's position, and it will be next fall before a rocket is ready which can match the present Russian luniks.

* * * * * * *

Dr. John Lindsay, head of NASA's solar physics program, reported that the space agency has a duplicate Moon satellite, but he said all present Atlas rockets are ticketed for definite projects and one would have to be diverted at great cost to try another Moon shot.

I have not brought this matter up with any thought of embarrassing anyone, nor do I propose to spend our time today discussing errors of the past. Nothing would be gained by that. Incidentally, I was out before the people when some of this happened. And some of them read that I was a member of this subcommittee, and they asked me some rather hard questions.

My only purpose in recounting this important bit of history is to bring to the fore one of our major concerns; namely, we want to be sure that the NASA program for fiscal year 1961 makes adequate provision for backup boosters—particularly the Atlas and Thor boosters on which we will be depending so heavily during the next several years.

This situation brings to mind two well known quotations. One refers to "Experience, the Universal Mother of Sciences." The other is that "Experience is the name everyone gives to their mistakes."

Whether we accept that definition of "experience" or the more conventional dictionary definition, I think we would all agree that our experience clearly demonstrates the need for applying a portion of the funds devoted to the space program to assuring that our schedules will be accomplished. I don't think we could make a worse mistake in our national affairs than to assume that the space program has no military value, or any other value. This space program is the frontier of our future.

Dr. Glennan, it is always a pleasure for us to have you give the subcommittee the benefit of your views. Now if you and the other members of your staff who are scheduled to testify would please stand, I will administer the oath.

Gentlemen, do each of you solemnly swear that your testimony before this committee today, or at any future day, will be the truth, the whole truth, and nothing but the truth, so help you God?

Dr. GLENNAN. I do.

Dr. DRYDEN. I do.

Mr. HORNER. I do.

We will place in the record at this point a copy of the bill under consideration, H.R. 10809. We will also insert a summary of the appropriation requests and the biographies of the witnesses.

(The document referred to follows:)

[H.R. 10809, 86th Cong., 2d sess.]

AN ACT To authorize appropriations to the National Aeronautics and Space Administration for salaries and expenses, research and development, construction and equipment, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of American in Congress assembled, That there are hereby authorized to be appropriated to the National Aeronautics and Space Administration for the fiscal year 1961 the sum of $915,000,000, as follows:

(a) For "Salaries and expenses," $170,760,000.

(b) For "Research and development," $621,453,000.

(c) For "Construction and equipment," $122,787,000, as follows:

(1) Langley Research Center, Hampton, Virginia: Hypersonic aerothermal dynamics facility and dynamics research laboratory, $11,957,000.

(2) Ames Research Center, Moffett Field, California: Centrifuge equipment, $980,000.

(3) Lewis Research Center, Cleveland, Ohio: Energy conversion laboratory and basic materials research laboratory, $9,100,000.

(4) Goddard Space Center, Greenbelt, Maryland: Payload testing facility; satellite systems laboratory; and utility installations, $9,500,000.

(5) Pilotless Aircraft Station, Wallops Island, Virginia: Precision trajectory determination system; operations computing center; and equipment modernization, $4,000,000.

(6) Jet Propulsion Laboratory, Pasadena, California: Land acquisition; modernization of laboratory facilities; solid propellant facility; liquid propellant test cell; and antenna range, $5,000,000.

(7) NASA Huntsville Facility, Huntsville, Alabama: Saturn static test facility; central laboratory and office facility; dynamic test facility; pressure test cell; and additions to existing facilities for structures engineering, guidance and control, fabrication, checkout, and assembly, $26,750,000.

(8) Atlantic Missile Range, Cape Canaveral, Florida: Completion of the Saturn launching complex, escape mechanism, hydrogen system, new Saturn launching complex, staging buildings, and addition to the engineering and laboratory building, $27,750,000.

(9) Various locations: Tracking facilities, $27,750,000.

(d) Appropriations for "Research and development" may be used for any items of a capital nature (other than acquisition of land) which may be required for the performance of research and development contracts: *Provided*, That none of the funds appropriated for "Research and development" pursuant to this Act may be used for construction of any major facility, the estimated cost of which, including collateral equipment, exceeds $250,000, unless the Administrator or his designee notifies the Committee on Science and Astronautics of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate of the nature, location, and estimated cost of such facility.

(e) When so specified in an appropriation Act any amount appropriated for "Research and development" and for "Construction and equipment" may remain available without fiscal year limitation.

(f) Appropriations other than "Construction and equipment" may be used, but not to exceed $20,000, for scientific consultations and any emergency or extraordinary expense upon the approval or authority of the Administrator and his determination shall be final and conclusive upon the accounting officers of the Government.

SEC. 2. Authorization is hereby granted whereby any of the amounts prescribed in subparagraph (1), (2), (3), (4), (5), (6), (7), (8), or (9) of subsection 1(c) may, in the discretion of the Administrator of the National Aeronautics and Space Administration, be varied upward 5 percentum to meet unusual cost variations, but the total cost of all work authorized under such subparagraph shall not exceed a total of $122,787,000.

SEC. 3. Any amount, not to exceed $5,000,000, of the funds appropriated for "Construction and equipment" pursuant to this Act, may be used to construct, expand, or modify laboratories and other installations, if found by the Administrator to be necessary because of changes in the national program of aeronautical and space activities or new scientific or engineering developments and if the Administrator determines that deferral until the next authorization Act would be inconsistent with the interest of the Nation in aeronautical and space activities, and in connection therewith to acquire, construct, convert, rehabilitate, or install permanent or temporary public works, including land acquisition, site preparation, appurtenances, utilities, and equipment: *Provided*, That upon reaching a final decision to implement, the Administrator or his designee shall notify the Committee on Science and Astronautics of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate of the cost of such construction, expansion, or modification including those real estate actions pertaining thereto: *Provided further*, That no such funds shall be used for construction, expansion, or modification if authorization for such construction, expansion, or modification has been previously denied by the Congress; and additional appropriations are hereby authorized for purposes of this section in the amount of $5,000,000.

SEC. 4. That paragraph 203(b)(2) of the National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2473(b)(2)), is amended by striking out "ten" and inserting in lieu thereof "thirteen," and by striking out "two hundred and sixty" and inserting in lieu thereof "two hundred and ninety."

Passed the House of Representatives March 9, 1960.

Attest:

RALPH R. ROBERTS,
Clerk.

SUMMARY OF APPROPRIATIONS REQUEST

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

APPROPRIATION SUMMARY

	Salaries and Expenses	Research and Development	Construction and Equipment	Total
APPROVED, FISCAL YEAR 1959:				
Independent Offices Appropriation Act, 1959; P.L. 85-844	$78,100,000	---	$23,000,000	$101,100,000
Supplemental Appropriation Act, 1959; P.L. 85-766	5,000,000	$50,000,000	25,000,000	80,000,000
Second Supplemental Appropriation Act, 1959; P.L. 86-30	3,186,300	---	---	3,186,300
Transfers from DOD (72 Stat. 433)	---	154,619,532	---	154,619,532
Total	$86,286,300	$204,619,532	$48,000,000	$338,905,832
APPROVED, FISCAL YEAR 1960:				
Supplemental Appropriation Act, 1960; P.L. 86-213	$91,400,000	$335,350,000	$73,825,000	$500,575,000
Appropriation transfer; P.L. 86-213	---	-15,000,000	15,000,000	---
Total	$91,400,000	$320,350,000	$88,825,000	$500,575,000
REQUESTED, FISCAL YEAR 1960:				
Supplemental estimates.....H.J.Res.621.	---	$12,200,000	$10,800,000	$23,000,000
REQUESTED, FISCAL YEAR 1961:				
Regular estimates.....HR 10809...	$170,760,000	$621,453,000	$122,787,000	$915,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SALARIES AND EXPENSES

	Number of employees at end of year			Appropriated		Requested
	1959	1960	1961	1959	1960	1961
NASA Headquarters	428	683	683	$5,538,860	$7,549,300	$9,890,000
Langley Research Center	3,297	3,220	3,220	30,568,970	27,445,500	29,295,000
Ames Research Center	1,478	1,440	1,440	16,299,035	14,257,050	15,244,000
Lewis Research Center	2,783	2,736	2,736	27,215,227	24,840,200	25,724,000
Flight Research Center	336	416	416	3,154,208	3,038,150	3,679,000
Goddard Space Flight Center	782	1,214	2,000	2,021,100	11,802,270	25,084,000
Wallops Station	171	225	300	1,356,820	1,700,100	2,678,000
NASA Huntsville Facility	---	100	5,500	---	227,000	58,313,000
Western Operations Office	7	32	46	94,815	338,930	515,500
Atlantic Missile Range Operations Office	4	20	26	20,000	201,500	278,000
Pacific Missile Range Operations Office	---	---	6	---	---	59,500
Wright-Patterson Liaison Office	---	---	---	17,265	---	---
TOTAL	9,286	10,086	16,373	$86,286,300	$91,400,000	$170,760,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

RESEARCH AND DEVELOPMENT PROGRAMS

Program	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1960 Supplemental	Fiscal Year 1961
AERONAUTICAL AND SPACE RESEARCH:				
Support of NASA plant	$1,097,651	$22,684,000	---	$51,345,000
Research grants and contracts	3,028,000	4,950,000	---	10,000,000
Support of JPL plant	8,156,500 1/	---	---	---
SCIENTIFIC INVESTIGATIONS IN SPACE:				
Sounding rockets	3,556,170	8,811,000	---	8,000,000
Scientific satellites	21,305,114	23,813,000	---	41,700,000
Lunar and planetary exploration	31,882,607	49,000,000	---	45,000,000
Vanguard	21,943,582 1/	---	---	---
SATELLITE APPLICATIONS:				
Meteorology	987,550	7,930,000	---	20,700,000
Communications	3,574,806	3,170,000	---	5,600,000
MANNED SPACE FLIGHT	46,416,333	74,962,000	$12,200,000	107,750,000
VEHICLE SYSTEMS TECHNOLOGY	1,903,651	6,737,000	---	21,200,000
SPACE PROPULSION TECHNOLOGY:				
Solid rockets	615,898	3,785,000	---	2,800,000
Liquid rockets	15,978,589	30,328,000	---	63,000,000
Nuclear systems technology	3,810,496	6,000,000	---	10,000,000
Space power technology	---	4,814,000	---	8,000,000
VEHICLE DEVELOPMENT:				
Scout	6,048,000	2,800,000	---	---
Delta	12,927,417	13,300,000	---	12,500,000
Vega	14,291,494	4,000,000	---	---
Centaur	4,000,000	37,000,000	---	47,000,000
Saturn	---	---	---	134,308,000
TRACKING AND DATA ACQUISITION	3,095,674	16,266,000	---	32,550,000
TOTAL	$204,619,532	$320,350,000	$12,200,000	$621,453,000

1/ Funded under program activities in 1960 and 1961.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SUMMARY OF CONSTRUCTION AND EQUIPMENT PROGRAMS

Program and location	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1960 Supplemental	Fiscal Year 1961
Aeronautical and space research facilities:				
Langley Research Center	$10,850,000	$4,535,000	---	$11,957,000
Ames Research Center	3,720,000	6,305,000	---	980,000
Lewis Research Center	7,800,000	6,660,000	---	9,100,000
Flight Research Center	---	1,850,000	---	---
Space flight development and operations facilities:				
Goddard Space Flight Center	3,867,000	14,070,000	---	9,500,000
Wallops Station	16,193,000	---	---	4,000,000
Jet Propulsion Laboratory	---	7,755,000	---	5,000,000
NASA Huntsville Facility	---	---	---	26,750,000
Atlantic Missile Range	---	740,000	4,000,000	27,750,000
Pacific Missile Range	---	760,000	---	---
Various locations:				
Equipment and instrumentation for:				
Minitrack net	95,000	4,205,000	---	4,750,000
Deep space net	2,550,000	3,500,000	---	8,000,000
Mercury net	2,425,000	28,995,000	6,800,000	15,000,000
Propulsion development facilities	500,000	7,950,000	---	---
Facilities for Rover program	---	1,500,000	---	---
Total	48,000,000	88,825,000	10,800,000	122,787,000
Transferred from Research and Development appropriation	---	-15,000,000	---	---
Appropriated to NACA	23,000,000	---	---	---
Appropriated to NASA	25,000,000	73,825,000	10,800,000	122,787,000
Total appropriations	$48,000,000	$73,825,000	$10,800,000	$122,787,000

BIOGRAPHIES

T. KEITH GLENNAN, ADMINISTRATOR

T. (Thomas) Keith Glennan is the first Administrator of the National Aeronautics and Space Administration, established October 1, 1958, under the National Aeronautics and Space Act of 1958.

As Administrator, Dr. Glennan heads a staff of scientists, engineers, technicians, and other employees engaged in research and development in aeronautics and space matters. In this position he is a member of the President's National Aeronautics and Space Council.

Glennan is president-on-leave of the Case Institute of Technology, Cleveland, Ohio, which he has headed since 1947.

Born in Enderlin, N. Dak., in 1905, Dr. Glennan earned a degree in electrical engineering from the Sheffield Scientific School of Yale University in 1927.

Following graduation, Glennan became associated with the newly developed sound motion picture industry, and later became assistant general service superintendent for Electrical Research Products Co., a subsidiary of Western Electric Co. During his career he was studio manager of Paramount Pictures, Inc., and Samuel Goldwyn Studios, and was briefly on the staff of Vega Airplane Corp.

Glennan joined the Columbia University Division of War Research in 1942, serving through the war, first as Administrator and then as Director of the U.S. Navy's Underwater Sound Laboratories at New London, Conn. For his work he was awarded the Medal of Merit.

At the end of World War II, Dr. Glennan became an executive of Ansco, Binghamton, N.Y. From this position he was called to the presidency of Case. During his 11-year-administration, Case rose from a primarily local institution to rank with the top engineering schools in the Nation. From October 1950 to November 1952, concurrent with his Case presidency, he served as a member of the Atomic Energy Commission.

Dr. Glennan has been very active in national and civic affairs. He was chairman of the board of the Institute for Defense Analysis, on the board of the National Science Foundation, and the Council on Financial Aid to Education. In Cleveland he took an important part in many civic activities.

Glennan is a fellow of the American Academy of Arts and Sciences, and a member of Sigma Xi, Tau Beta Phi and Chi Phi. He has been awarded several honorary degrees of doctor of science.

Dr. and Mrs. Glennan (the former Ruth Haslup Adams) have four children. They live at 4740 Connecticut Avenue NW., Washington, D.C.

HUGH LATIMER DRYDEN, DEPUTY ADMINISTRATOR

Hugh Latimer Dryden was appointed Deputy Administrator of the National Aeronautics and Space Administration on August 8, 1958. Before that date he was for 11 years Director of the National Advisory Committee for Aeronautics. As such he had charge of the Nation's flight research establishment with nearly 8,000 employees, three large laboratories and two field stations. The NACA provided scientific information useful in the design of aircraft, missiles, and space craft. Its organization and functions were absorbed within the NASA as of September 30, 1958.

Dr. Dryden's career has been in aeronautics and related sciences, and he has made many technical contributions by his research in high speed aerodynamics, fluid mechanics and acoustics. He has published more than 100 technical papers.

Born July 2, 1898, in Pocomoke City, Md., Dr. Dryden was reared in Baltimore. He was an honor student at Johns Hopkins University completing the 4-year arts course in 3 years. While continuing his studies at the graduate school of the same university, he conducted research in fluid mechanics at the National Bureau of Standards. He was granted the degree of doctor of philosophy in 1919.

While he was head of the Bureau of Standards' Aerodynamics Section from 1920 to 1934 he made some of the earliest studies of airfoil characteristics near the speed of sound. He also did pioneering work on turbulence and the mechanics of the boundary layer. He was promoted to Chief of the Bureau's Mechanics and Sound Division in 1934, to Assistant Director in January 1946, and to Associate Director 6 months later.

Results of his work dealing with the properties of airfoils at high speeds, wind tunnel investigations, boundary layer and turbulence, noise suppression,

and other aeronautical matters have been published in professional and trade journals.

Dr. Dryden was the first American to be selected to deliver, in 1938, the Wright Brothers lecture before the Institute of the Aeronautical Sciences. He is an honorary fellow of the Institute and served as its president in 1943. In 1956 he was named an honorary fellow of the Royal Aeronautical Society.

For more than two decades he has served on numerous scientific advisory groups. In World War II he headed the research project which developed the first American combat missile, the Bat, and served on committees advising the Joint Chiefs of Staff, NACA, Army Ordnance Department, and Army Air Force. In 1945 he was appointed Deputy Scientific Director of the AAF Scientific Advisory Group and toured Europe studying foreign scientific work in aeronautics and guided missiles.

He is now a member of numerous Government scientific advisory committees serving the President, the Department of Defense, the Air Force, the Army and other Federal agencies, and the North Atlantic Treaty Alliance. Since 1955 he has been home secretary of the National Academy of Sciences.

He is a member of more than a dozen American and international professional societies and holds seven honorary degrees. He lives with his family in suburban Washington.

RICHARD E. HORNER, ASSOCIATE ADMINISTRATOR

Richard E. Horner was appointed Associate Administrator of the National Aeronautics and Space Administration on June 1, 1959. Under T. Keith Glennan, Administrator, and Hugh L. Dryden, Deputy Administrator, he is responsible for the general management of NASA's operations which include laboratories, research centers, rocket testing and launching facilities, and a world network of tracking stations.

Horner was Assistant Secretary of the Air Force for Research and Development, from July 1957 to June 1959. He had been Acting Assistant Secretary since February 1956.

Born October 24, 1917, in Wrenshall, Minn., he is a graduate of the University of Minnesota, where he received a bachelor of science degree in aeronautical engineering in 1940. He received a master's degree from Princeton University in 1947.

Horner was commissioned a second lieutenant, Army Air Corps, in 1940 and served in World War II as a pilot with tactical units in the corps and with the Air Materiel Command. He was awarded the Silver Star, the Air Medal with four clusters and the Presidential Unit Citation. In 1949, he was released from active duty with the rank of colonel, U.S. Air Force.

He was employed in a civilian capacity as aeronautical development engineer at the Air Force Flight Test Center, Edwards Air Force Base, Calif. In 1952, he became Technical Director of the test center. In 1955, he was named Deputy for Requirements to the Assistant Secretary of the Air Force for Research and Development, holding that position until his appointment as Acting Assistant Secretary.

Horner is married to the former Jean Margaret Hodgson of Waseca, Minn. They have two children, Richard James and Judith Rae, and live at 3612 N. Peary Street, Arlington, Va.

IRA H. ABBOTT, DIRECTOR, ADVANCED RESEARCH PROGRAMS

Ira H. Abbott was appointed Director, Advanced Research Programs, on July 1, 1959. He joined the National Advisory Committee for Aeronautics, the predecessor of the NASA, in 1929 as a junior aeronautical engineer at the Langley Aeronautical Laboratory, Virginia. During his 19 years at Langley he served as Assistant Chief of the Full-Scale Research Division and later Assistant Chief of the Research Department.

Transferred to NACA headquarters in Washington, D.C., in 1947 as aeronautical consultant, Abbott was named Assistant Director of Research (Aerodynamics) in 1949. Since the NASA was established, he has supervised basic research programs in fluid mechanics; aircraft, missile, and spacecraft aerodynamics, and control guidance and navigation.

Born July 18, 1906, at Wolfeboro, N.H., Abbott was graduated from Newburyport (Mass.) High School. He received a bachelor of science degree from Massachusetts Institute of Technology in 1929.

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Abbott is a member of the Civilian-Military Liaison Committee (authorized by the National Aeronautics and Space Act of 1958), and a fellow of the Institute of the Aeronautical Sciences. From 1957 to 1958 he was Chairman of the Wind Tunnel Panel of NATO's Advisory Group on Aeronautical Research and Development.

Mr. and Mrs. Abbott (the former Martha Leola Streeter) and their three children live at 3704 Bradley Lane, Chevy Chase, Md.

MAJ. GEN. DON R. OSTRANDER, USAF DIRECTOR, LAUNCH VEHICLE PROGRAMS

Maj. Gen. Don R. Ostrander was appointed NASA Director of launch vehicle programs on December 16, 1959. On Air Force assignment to the civilian space agency, he is in charge of NASA booster development and rocket launching operations. Previously he was deputy director of the Advanced Research Projects Agency.

General Ostrander, 45, is a 1937 graduate of the U.S. Military Academy. Born in Stockbridge, Mich., he attended local schools and studied engineering at Western State College, Michigan, before entering West Point.

During World War II, he served as ordnance armament officer with the 8th Air Force Interceptor Command in England. In this role, he helped modify the P–38 airplane to accommodate a Norden bombsight and bombadier. His decorations include the Legion of Merit with cluster.

He has held a variety of administrative posts within the Air Force Air Research and Development Command going back to 1951, working on weapons systems and missile programs. He moved into the ARPA post after more than a year's duty as assistant to the NATO Assistant Secretary General for guided missile production in Paris.

He was promoted to brigadier general in October 1954, and received his second star in March 1958.

General and Mrs. Ostrander (the former Frances Dunn) and their three children live in Alexandria, Va.

ABE SILVERSTEIN, DIRECTOR OF SPACE FLIGHT PROGRAMS

Abe Silverstein is Director of Space Flight Programs of NASA. Before the NASA was established on October 1, 1958, he was Associate Director of the Lewis Flight Propulsion Laboratory, Cleveland, Ohio, a research center of the National Advisory Committee for Aeronautics, which formed the nucleus of the NASA.

Silverstein directs those NASA programs charged with mission planning, payload design and development, and inflight research and operation. Development programs under his direction include space probes and manned and unmanned satellite systems.

Silverstein is a native of Terre Haute, Ind., where he attended local grammar and high schools. He earned a bachelor of science in mechanical engineering degree in 1929, and a mechanical engineering professional degree in 1934 from Rose Polytechnic Institute. He was awarded an honorary doctorate by Case Institute of Technology in 1958.

Silverstein joined the National Advisory Committee for Aeronautics in 1929, and soon after helped design the full-scale wind tunnel at the Langley Aeronautical Laboratory. He later was placed in charge of this facility, and directed research which increased the high-speed performance of most of the combat aircraft of World War II. This work was recognized as a major factor in gaining U.S. air superiority during the war.

In 1943, he was transferred to the Lewis Laboratory at Cleveland to select and train a staff which he directed in research at the altitude wind tunnel. These investigations led to significant improvements in both reciprocating and early turbojet aircraft engines. He also pioneered with large-scale ramjet engines, now used on certain missiles.

At the end of World War II, Silverstein was directing the work at several major research facilities at Lewis. He directed the erection of the $9 million NACA 8-by 6-foot supersonic wind tunnel, first operated in 1949, and the $33 million NACA 10- by 10-foot supersonic wind tunnel, completed in 1956. These facilities, the largest wind tunnels of their kind in the world, have greatly accelerated the development of supersonic aircraft. In 1952, he was appointed Associate Director of the Lewis Laboratory, a post he held until he was named to the headquarters staff of the NASA.

Silverstein was a member of several NACA committees and subcommittees including: Committee on Aerodynamics, 1946–47; Subcommittee on Self-Propelled Guided Missiles, 1945–47; Subcommittee on Internal Flow, 1947; Subcommittee on High-Speed Aerodynamics, 1945–57; Committee on Powerplants for Aircraft, 1951–57; and the Special Committee on Space Technology, 1958.

He served as chairman of the Cleveland section of the Institute of Aeronautical Sciences, 1946–47. He was a member of the committee on arrangements for the joint meeting of the Institute of the Aeronautical Sciences and the Royal Aeronautical Society, held in New York City in 1949. The Assistant Secretary of Defense for Research and Development appointed him a member of the Technical Advisory Panel on Aeronautics for the year 1955, and chairman of the ad hoc working group on rockets for 1956. He was a member of the Scientific Advisory Board of the Chief of Staff, U.S. Air Force for 1956 and 1957, and chairman of the OASD Technical Advisory Panel on Aeronautics, ad hoc group on Propulsion for Aircraft and Missiles. He was a member of the Assistant Secretary of Defense's steering group of the Advisory Panel on Aeronautics for 1958.

Silverstein was American representative to the Joint Meeting of the Institute of the Aeronautical Sciences and the Royal Aeronautical Society, in London, in 1947. He delivered the annual Wright Bros. lecture before the IAS in 1949.

He is a member of Tau Beta Pi, and a fellow of the Institute of the Aeronautical Sciences.

Silverstein, his wife Marion, and their three children live at 7205 Rollingwood Drive, Chevy Chase, Md.

WERNHER VON BRAUN, DIRECTOR, DEVELOPMENT OPERATIONS DIVISION, GEORGE MARSHALL SPACE FLIGHT CENTER

Wernher von Braun was born in Wirsitz, Germany, in 1912. Because his father was a government official who moved about Germany often, he gained his early education in various grammar and high schools from 1918 to 1930.

In 1932, Dr. von Braun received his bachelor's degree in Aircraft Engineering from the Institute of Technology at Zuerich, Switzerland. Two years later, he earned his Ph. D. in physics from the University of Berlin.

From 1932, when he joined the German Ordnance Department, until 1937, Dr. von Braun was chief of the liquid fuel rocket development at Kummersdorf, approximately 50 miles south of Berlin. In 1937, the Kummersdorf rocket development was transferred to a newly formed rocket center, Peenemuende, of which Dr. von Braun became the Technical Director. The center's main mission was the development of the V–2 rocket. Other work included the development of an antiaircraft missile, the Wasserfall, and liquid fuel JATO units for heavy bombers and fighter aircraft.

In 1945 Dr. von Braun came to the United States with six other scientists under contract to the U.S. Army Ordnance Corps. His first assignment was as advisor for V–2 high-altitude research firings at White Sands Proving Ground, N. Mex. Later he was made project director for a guided missile development unit at Fort Bliss, Texas, where he was joined by about 120 scientists and technicians who had worked with him at Peenemuende.

From 1950 to 1956 Dr. von Braun was Chief of the Guided Missile Development Division at Redstone Arsenal, Huntsville, Ala. Since 1956 he has been Director of Development Operations Division, Army Ballistic Missile Agency, Huntsville.

Dr. von Braun received his U.S. citizenship in May 1955.

WILLIAM H. PICKERING, DIRECTOR, NASA-CAL TECH JET PROPULSION LABORATORY

William H. (Hayward) Pickering is Director of the Jet Propulsion Laboratory, Pasadena, Calif., which is operated by the California Institute of Technology under contract to the National Aeronautics and Space Administration.

Dr. Pickering directs the research and development work of about 2,300 scientists, engineers, and supporting staff, in the fields of rocket propellants, and in electronics, communications, and guidance used in space technology.

Dr, Pickering is a native of Wellington, New Zealand. He earned a bachelor of science degree in 1932, a master of science degree in 1933, and a doctorate in physics in 1936 at California Institute of Technology.

He has been a member of the faculty of Cal Tech since 1932 and was appointed professor of electrical engineering in 1946. He has been associated with the Jet Propulsion Laboratory since 1944. He later was in charge of electronics work

and in 1950 was given the responsibility for the Corporal missile program at JPL. In 1954, he was named Director of the laboratory.

Dr. Pickering's fields of research have included cosmic rays, telemetering from balloons and rockets, microwave propagation, development of cosmic ray radiosonde, and missile guidance problems.

His memberships have included the Scientific Advisory Board of the U.S. Air Force, a number of other committees of the Department of Defense, and the U.S. National Committee's Technical Panel on the earth satellite program and its working group on tracking and computation. He is a fellow of the Institute of Radio Engineers, the American Rocket Society, and a member of the American Institute of Electrical Engineers.

His awards include the 1957 James Wyld Memorial of the American Rocket Society; a special award by the Los Angeles Chamber of Commerce in 1958 for creative achievements; and a scientific achievement award from the greater Los Angeles Chapter of the Association of the U.S. Army in 1958.

Dr. Pickering is married to the former Muriel Bowler. Dr. and Mrs. Pickering and their children, William B., 19, and Anne E., 16, live at 2514 Highland Avenue, Altadena, Calif.

HARRY J. GOETT, DIRECTOR, GODDARD SPACE FLIGHT CENTER

Harry J. Goett became Director of NASA's Goddard Space Flight Center September 1, 1959. As Director, Goett reports to Abe Silverstein, NASA Director of Space Flight Development.

Goett heads a staff of scientists, technical and administrative employees engaged in basic research, and in developing satellites, space probes, vehicles and systems for tracking, communications, and data reduction.

Pending completion of new quarters for the Center at Greenbelt, Md., units of the organization are located in several temporary sites at Washington, D.C., and Langley Field, Va. Temporary main office is at 4555 Overlook Drive, Washington, D.C.

Goett, beginning in 1948 directed some of the first space research of the NASA's predecessor agency, the National Advisory Committee for Aeronautics, using a special wind tunnel to reproduce low densities found at extreme altitudes. He has been engaged in research in aerodynamics and the operating problems of flight more than 23 years. Since NASA was established October 1, 1958, until his appointment, he provided technical liaison for the agency's west coast satellite and space probe activities, including the Pioneer series, one of which was put into orbit around the sun.

Goett was chairman of a technical review team which contributed improvements to rocket vehicle systems used by NASA. He is a member of the Research Advisory Committee on Control, Guidance and Navigation, and Research Steering Committee on Manned Space Flight, and head of the astronomical satellite team of the NASA Ames Research Center.

In his career with NACA Goett for many years was a member of the Subcommittee on Automatic Stabilization and Control, and of the Working Group on Instrumentation of the Special Committee on Space Technology which was formed in 1957. Before his appointment, he was Chief of the Full Scale and Flight Research Division, Ames Research Center.

Born November 14, 1910, in New York City Goett attended elementary and high schools there. He was graduated from Holy Cross College in 1931 with bachelor of science degree, and 2 years later earned the degree of aeronautical engineer at New York University. He took additional studies of law at Fordham University.

From 1933 to 1935, he supervised machinery installations for the Waterbury Rope Co., New York City, then was employed by the Sumerill Tubing Co. and the Douglas Aircraft Co. for a short period. He joined the research staff of NACA's Langley Aeronautical Laboratory in July, 1936. He was transferred in July, 1940, to Moffett Field, Calif., where the Ames Laboratory was under construction.

Goett's research work has covered a broad range of problems in aerodynamics and operations, including atmosphere reentry, aerodynamic heating, low speed and vertical takeoff aircraft, stability and control, inflight studies of boundary layer control, automatic flight and jet engine thrust reversers. Under his direction, the Division conducted successfull research on a thrust reverser and flight approach control for jet airplanes. Goett has written or coauthored a dozen technical reports.

Senator STENNIS. Now, the Chair wants to express special appreciation for the fact that the Senator from Maine, Mrs. Smith, with her usual energy and alertness, has gotten here on time for this meeting, even though she, as I understand, was on a program in Maine last evening. I appreciate very much you making that special effort to get back.

Senator Young, we are glad you are here too. And Senator Martin, you are another one of our standbys.

Doctor, if you are ready, we will proceed. And let me explain now, I have a call and must go briefly to another meeting at 2:30. Senator Young, I am going to ask you now to preside during my temporary absence.

Doctor, proceed, please.

TESTIMONY OF DR. T. KEITH GLENNAN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; DR. HUGH LATIMER DRYDEN, DEPUTY ADMINISTRATOR, NASA; AND RICHARD E. HORNER, ASSOCIATE ADMINISTRATOR, NASA

Dr. GLENNAN. Thank you, Mr. Chairman, and members of the committee.

Before reading the statement which I have prepared for this session, I would like to say that we find—that is, the technical and scientific officials in NASA and industry—have found the printed copies of the hearings which you spoke of very useful indeed. We think that it is a very good thing to have this brought up to date and distributed again. We are very happy to work on that project with you.

Senator STENNIS. Thank you, Doctor. You and your staff do most of that work. Now, let us close the outside door so that we may proceed without interruption.

Dr. GLENNAN. I want to thank you for this opportunity to present NASA's $915 million budget appropriation request for fiscal year 1961 and to discuss with you the Nation's space exploration program.

As in the past, my associates will present, in any detail you may desire, the broad sweep of the significant and complex program for which this sum is required.

I would like, with your indulgence, to deal briefly with several facets of our program which I think will be of interest to the committee.

First, I want to state our position in comparison with that of the Soviet Union in the field of space exploration. To support our statements, we have prepared a frank assessment of United States-Soviet capabilities and accomplishments.

Second, I will delineate our "10-year plan" with particular emphasis on the activities programed for the early years of that plan. I speak of emphasis on the program of the next few years because research and development activities, by their very nature, do not permit of detailed planning extending over too great a span of time. But we can and do point out the long term objectives and indicate the path we intend to follow toward those objectives.

Finally, I will describe our funding requirements for the next fiscal year.

COMPARISON OF U.S. AND U.S.S.R. IN SPACE EXPLORATION

As we informed the Congress a year ago, we are unable as of the present time, to match our competitor in the weightlifting capability of launch vehicle systems. The reasons for this situation have been stated many times but may well be summarized again.

As you will remember, in the late 1940's the United States elected to continue and further develop the heavy bomber as the delivery system for nuclear weapons. The Soviet Union, having a different base on which to construct its defense position—no heavy bomber force nor bases from which to stage intercontinental flights—chose to build high-thrust rocket systems for ballistic missiles to perform this same task.

Thus, they gained a 5- to six-year head start in the concentrated research and development that ultimately led to the rockets used in their ballistic missile systems. Further, at the time they made their decision on the size of their ballistic missile delivery systems they had to base them on the existing state of the art of warhead development—and so chose a larger launching vehicle than was later selected by us.

Our decision to develop rocket-propelled ballistic missile systems was made after nuclear warhead development had proceeded to the point where we could plan on smaller overall systems to deliver the same punch.

While our rockets can carry a warhead to the desired target with accuracy in the same manner as the Soviet rockets can, their more powerful rockets have given them an early lead on attention-catching, spectacular flights in space.

Practically all of our launchings have employed the 150,000-pound-thrust Thor and Jupiter rockets. In only three experiments has the United States employed the higher thrust Atlas. And in no single case involving the use of any of these rockets as first stage boosters have we been able fully to exploit the thrust capability of the rocket. Even today, we must continue to use as upper stages in these systems rockets available from other programs which have been modified and adapted for that purpose.

Based on their substantially earlier start in the development of large rockets, Soviet scientists have had at their command a rocket which our scientists and engineers estimate is in the 600,000- to 800,000-pound-thrust range. They have spoken of multistage launch vehicles, and some of their mission accomplishments would indicate that they have used upper stages with these very powerful first stage rockets.

Undoubtedly they are continuing to refine and optimize their present units while developing even more powerful rockets and launch vehicle systems.

This disparity in thrust enables the Soviet Union to undertake very difficult space missions, some of which are completely denied to us today. It is reasonable to assume that the Russians can move more rapidly from concept, to drawing board, to the construction and launching of payloads because they are not limited by the weight restrictions we are experiencing.

I suspect, as I have said in previous testimony before the Congress, that they can avoid the time-consuming business of miniaturization, optimum-packaging, and other weight-saving practices. Moreover, their ability to carry heavy payloads improves the probability of suc-

cess in any particular experiment because they have adequate weight-carrying margins to permit the employment of redundancy or duplication in many elements of their guidance, control, and communications subsystems.

Urgent and, I believe, effective efforts are being made, both by NASA and by the Department of Defense, to develop a family of launch vehicle systems that will correct this imbalance. This activity is basic to our continuing progress in both military and nonmilitary space experimentation.

We are developing a small group of multipurpose launch vehicles which, through repeated usage by NASA and Defense, should become very reliable systems. The family consists of the Scout, the Thor-Agena B, the Atlas-Agena B, the Atlas-Centaur, the Saturn, and the Nova vehicle concept which will ultimately be developed to utilize the 1,500,000-pound, single-chamber, F–1 engine now under development. Of these, all are NASA development responsibilities excepting only the Agena B stages to be used with Thor and Atlas rockets.

Estimating availability dates in a technology as complex as high-performance launch vehicle systems is an uncertain business, but NASA and Defense have scheduled initial launchings for these systems as follows:

Scout: A relatively low-cost, utility vehicle, mid-1960.

Thor–Agena B: By the Department of Defense, mid-1960. (For the next year or so, NASA will use a less powerful interim vehicle in this general class, the Thor–Delta, scheduled for initial launch in April 1960.)

Atlas–Agena B: By the Department of Defense, late 1960; by NASA in mid-1961.

Atlas–Centaur: The first system to use liquid hydrogen as a fuel, an important development, in 1961.

Saturn: If granted our full fiscal year 1961 budget request, we expect to meet the following schedule:

Static test of eight-engine cluster, spring 1960.

Launch of first stage with dummy upper stages, by summer of 1961.

Launch of two-stage vehicle, fall of 1962.

Launch of three-stage vehicle, late 1963.

Launch of first operational vehicle, before the end of 1964.

Looking further down the road, and another billion-plus dollars into the future, we expect to have the Nova vehicle, consisting of a cluster of F–1 engines, with total thrust of 6 to 12 million pounds, sometime after 1965.

Senator STENNIS. What is that now? Ten to twelve million?

Dr. GLENNAN. Six to twelve million pounds.

Senator STENNIS. All right. Thank you. I could hardly comprehend the 12 million.

Dr. GLENNAN. That is four to eight of the engines clustered.

Now, in spite of this limitation in thrust, we have been accomplishing a great deal. We attempted to launch 19 Earth satellites and 1 deep-space experiment during calendar year 1959. These were NASA and the Department of Defense combined.

Of these, NASA launched nine Earth satellites and one deep-space probe of which five satellites were successful. To make the record

complete, the Department of Defense, in its Discoverer series of developmental satellites, launched six satellites into orbit in nine attempts, and failed in its attempt to launch a Transit navigation satellite experiment.

In that same period, calendar year 1959, the Soviet Union launched three highly successful deep space experiments.

From October 4, 1957 to the present, the score is as follows:

United States: Fifteen satellites launched successfully, six of which are still in orbit. Two continue to provide valuable data to the world scientific community. They are Vanguard I and Explorer VII.

U.S.S.R.: Three satellites launched successfully, one of which is still in orbit—Sputnik III. It is a quiet satellite at the moment.

United States: Four deep-space probes launched successfully, two of which achieved their objectives substantially—Pioneers IV and V.

U.S.S.R.: Three deep-space probes launched successfully, each of which appears to have achieved its principal objective. One is in orbit about the Sun, a second continues in a highly elliptical orbit about the Earth; the third was demolished in a hard landing on the Moon.

It is important to note that no Soviet failures have been reported. Secrecy has surrounded all of their launchings.

A comparison of the results obtained in the two programs makes clear the preponderance of spectacular firsts achieved by the Soviet Union, while our own program has yielded less spectacular, but on the whole equally or more significant, scientific results.

Dr. Homer Newell, Deputy Director of NASA's Office of Space Flight Programs, has prepared, within the last few months, an evaluation of United States and U.S.S.R. progress which is as objective an analysis as I believe now exists. While it is too lengthy for me to read here, I would like to suggest, Mr. Chairman, that it be inserted in the record as an appendix to my statement.

Senator STENNIS. Just a moment. It will be agreeable, all right. We sometimes put those in the files, and have them available to the committee and the staff. You think that this is very important and should go in the record?

Dr. GLENNAN. I do, Mr. Chairman. I think this will make this much more complete.

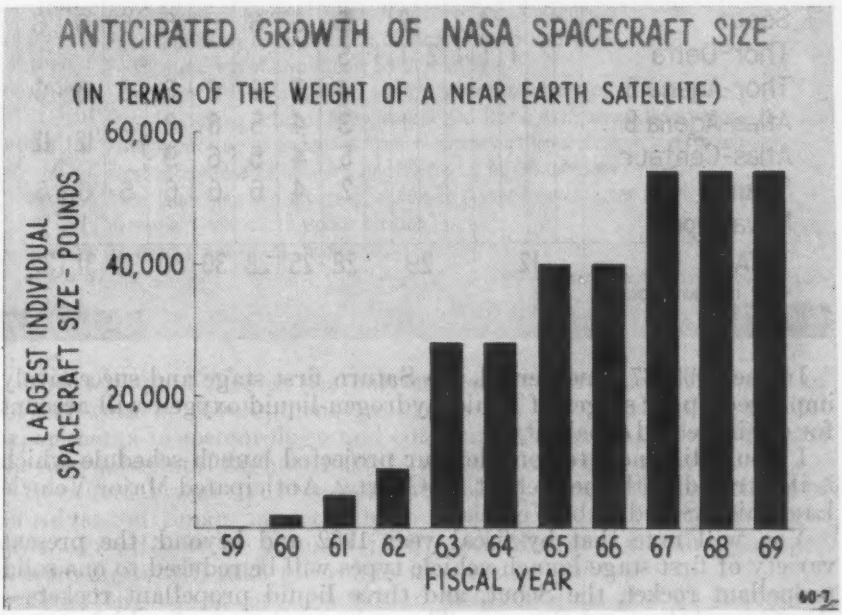
Senator STENNIS. Very well. Without objection it will be so ordered. (See p. 23.)

NASA'S TEN-YEAR PLAN

Dr. GLENNAN. I would now like to turn to the long term objectives of our national program of space exploration which we have embodied in a 10-year plan.

The first chart (Chart 1, Anticipated Growth of NASA Spacecraft Size) outlines the anticipated growth in spacecraft weight from year to year. Spacecraft, incidentally, is a new term that we apply to that part of the vehicle which is to be placed into an Earth orbit or on a departure trajectory from the Earth.

CHART 1

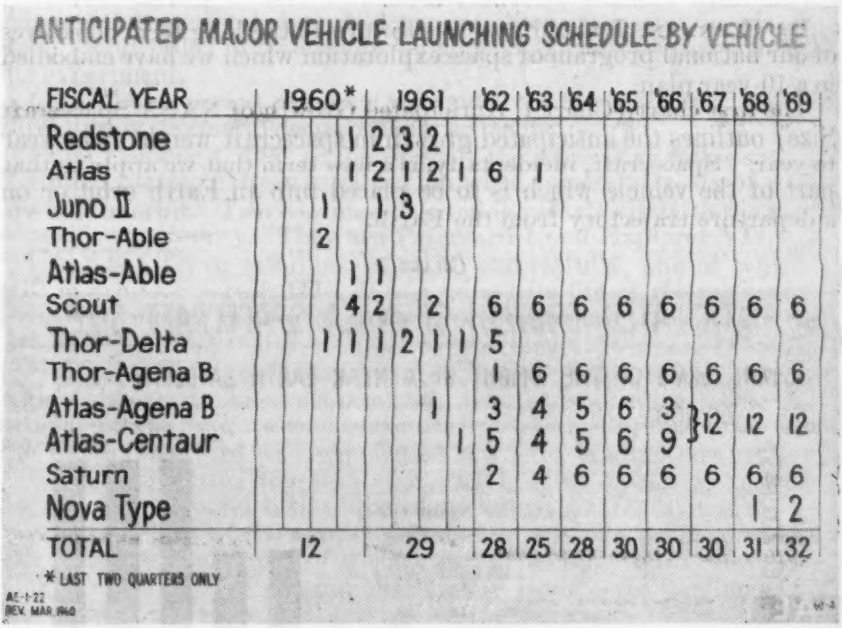


The term includes the propulsion, attitude controls, and guidance units for maneuvering the spacecraft as well as the instrumentation for the experiments to be undertaken.

For comparative purposes, the chart measures spacecraft weight that can be projected into a low altitude Earth orbit of about 300 miles.

In the early years our increasing capabilities will come about through use of the Thor-Agena B, Atlas-Agena B, and Atlas-Centaur.

CHART 2



In the 1963–67 time period, the Saturn first stage and successively improved upper stages of liquid hydrogen-liquid oxygen will account for our increased capability.

I would like now to consider our projected launch schedule which is illustrated in the next chart. (Chart 2, Anticipated Major Vehicle Launching Schedule by Vehicle).

You will note that by fiscal year 1962 and beyond, the present variety of first stage launch vehicle types will be reduced to one solid propellant rocket, the Scout, and three liquid propellant rockets—the Thor, Atlas, and Saturn. Through restriction of vehicle types, and more intensive experience with each, we expect to achieve long-needed reliability.

Beyond Saturn, the use of chemical fuels would lead us, as I have said earlier, to a vehicle concept known as Nova, with four to six times the Saturn thrust based upon use of the F–1 engine. Depending on funding levels, development testing on Nova would occur in the post 1965 time period.

It should be noted that, together with the Atomic Energy Commission, we will be developing nuclear rocket systems which promise substantial advantages for particular missions involving heavy payloads. This program is moving solidly ahead and will be discussed by others later in these presentations.

The next chart (Chart 3, NASA Mission Target Dates) deals with NASA's mission target dates. This listing has been developed to reflect the probable pace of technological advance during the next several years, it being assumed that funding necessary to maintain this pace will be made available.

CHART 3

NASA MISSION TARGET DATES

Calendar Year	
1960	First launching of a Meteorological Satellite.
	First launching of a Passive Reflector Communications Satellite.
	First launching of a Scout vehicle.
	First launching of a Thor-Delta vehicle.
	First launching of an Atlas-Agena-B vehicle (by the Department of Defense).
	First suborbital flight of an astronaut.
1961	First launching of a lunar impact vehicle.
	First launching of an Atlas-Centaur vehicle.
	Attainment of manned space flight, Project Mercury.
1962	First launching to the vicinity of Venus and/or Mars.
1963	First launching of two stage Saturn vehicle.
1963-1964	First launching of unmanned vehicle for controlled landing on the moon.
	First launching Orbiting Astronomical and Radio Astronomy Observatory.
1964	First launching of unmanned lunar circumnavigation and return to earth vehicle.
	First reconnaissance of Mars and/or Venus by an unmanned vehicle.
1965-1967	First launching in a program leading to manned circumlunar flight and to permanent near-earth space station.
Beyond 1970	Manned flight to the moon.

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You will note that in the current year we are initiating tests of several vehicle development programs as well as the first orbital experiments in meteorology and communications. Also included are the first suborbital flights of the astronauts later this year.

In calendar year 1961 we will be working toward the launching of an advanced lunar impact vehicle and initiation of Centaur flight tests. If all goes as planned in Project Mercury, the first manned orbital flight will take place late in calendar 1961.

From this point on, the major milestones in the 10-year plan include a comprehensive program of exploration of the Moon and the nearby planets, and development of the Saturn vehicle to provide preliminary data leading toward manned circumlunar flight in the early years of the next decade.

Such are the major objectives of NASA as we now see them. We are concentrating upon lunar experiments for many reasons. The Moon is an object of great scientific interest; it may hold many keys to the origin of the Earth. Furthermore, success in the lunar program will provide us with the experience to attempt flights to the planets later on—probably in 1962 and beyond. In short, we will be able to perfect our communications, guidance, and propulsion systems using lunar flight as a development tool.

In viewing this chart, I think it necessary again to point out that in the research and development business it is dangerous, if not foolhardy, to pinpoint dates for particular achievements too far into the future.

Long-range objectives can and have been set. In the early years of the decade we suggest dates by which technological progress should

permit us to attain particular objectives. This plan will be updated annually to serve as the guide for our programing activities.

The 10-year plan I have discussed so briefly will call for somewhat more than $1 billion in fiscal year 1962 and upwards of $1½ billion annually within the next 5 years.

It is probable that this activity, if carried out with consistency and determination, will involve the expenditure of at least $12 to $15 billion in the next decade.

One of the characteristics of research and development activities in any field is that useful and productive work cannot be expected if the support is provided on a start-stop basis.

Fluctuations between great extremes result in good people leaving the program. It is extremely important that we develop an imaginative, technologically sound program which can be supported on its merits as one promising real values—not necessarily immediately important in an economic sense—but promising real values in the ongoing development of man, his society, and this Nation. We believe we have developed such a program.

FISCAL YEAR 1961 BUDGET REQUEST

I would now like to discuss with you the principal items in the fiscal year 1961 budget appropriations request. Our two highest priority subjects—Projects Saturn and Mercury—account for a considerable portion of the increase over 1960. Both enjoy a DX priority rating.

With the acquisition of the Marshall Space Flight Center under the direction of Dr. von Braun, we have begun an acceleration of the Saturn project. The fiscal 1961 request allots a total of $230 million for the super booster. With this requested funding we will advance the booster's completion by one year, give or take a month.

As I have said, we expect to launch the first operational Saturn before the end of 1964. At earlier dates, useful flights may well be made. I doubt that the Soviet Union will exceed us in thrust capability after that time.

The research and development segment of the fiscal 1961 request accounts for $621,453,000. Of this item, we allot $134,308,000 for Saturn. The remaining $95,692,000 earmarked for the project is carried in the construction and equipment and salaries and expenses budget categories.

We are nearly doubling the funds for the F–1 engine—from $24.200,000 in fiscal 1960 to $41 million in fiscal 1961.

Turning now to Project Mercury. As I indicated earlier, we plan to launch an astronaut on the first of numerous ballistic training flights down the AtlanticMissile Range from Cape Canaveral later this year. In a Mercury capsule launched by a Redstone rocket, the astronaut will experience 5 minutes of weightlessness, reach an altitude of 120 miles and a distance of 200 miles during his 13-minute flight. During the next 2 to 3 years 20-odd testing, training, and orbital flights are scheduled in Project Mercury.

As you well know, the compressed time-phasing of Project Mercury has made it necessary to undertake research, development, design, and fabrication simultaneously. Hence modifications to design, arrangement, and structure must be made during the conduct of the program.

Efforts to make the Mercury system as safe as humanly possible have inevitably added to the cost. The project will require

$107,750,000 in research and development funds alone in the fiscal 1961 request.

Our scientific investigations in space—sounding rockets, satellites, and space probes—will account for $94,700,000. Space propulsion technology, which encompasses research and advanced development on solid and liquid rockets, nuclear systems technology and space power technology is allotted $83,800,000.

The construction and equipment portion of the request totals $122,787,000. This appropriation provides for the modernization of existing facilities and the purchase of major equipment items.

The three major items in this category are: $27,750,000 for the Mercury, minitrack, and deep-space tracking networks; $26,750,000 for the George C. Marshall Space Flight Center at Huntsville, including construction of a second static test stand facility for Saturn; and $27,750,000 for a new Saturn launching complex at AMR and other necessary facilities.

Improvements at Langley, Ames, Lewis, Goddard, the Jet Propulsion Laboratory, and Wallops Island account for the balance of the funds.

Finally, the salaries and expenses item has grown from $91,400,000 in fiscal 1960 to $170,760,000 in fiscal 1961. About 75 percent of this increase is required for the first full year funding of the 5,500-man staff at the Marshall Center.

We also plan to increase the staff at Goddard from 1,214 to 2,000 persons and at Wallops from 225 to 300 individuals. Our remaining research centers—Ames, Lewis, Langley—will maintain their present staffing levels.

This, of course, has been a very general review of the fiscal 1961 request. I would be remiss if I did not acknowledge the very great support and encouragement given to me and to NASA by the chairman and the members of this committee.

You may be sure that we are sparing no efforts to continue to deserve the faith you have thus far shown. More successes of the Pioneer V type will provide proof of the validity of that faith—and we confidently expect to have more such spectacularly successful flights. It is my strongly held opinion that the program my associates will outline for you deserves your approbation.

Thank you for your courteous attention—and now I await your pleasure before Dr. Dryden discusses our international activities, results of past launchings, and the schedule for the coming year.

(The article by Dr. Homer Newell referred to on p. 18 is as follows:)

United States and U.S.S.R. Space Science Results

Homer E. Newell, Jr., Deputy Director, Office of Space Flight Programs, National Aeronautics and Space Administration

RESULTS OBTAINED

The United States has been using sounding rockets for upper air research and rocket astronomy since the close of World War II. WAC Corporal, V–2, Viking, Aerobee, Aerobee-Hi, Nike-Deacon, Nike-Cajun, Nike-Asp, and Rockoons were used. Altitudes attained were below 200 miles for the most part. Many hundreds of rockets were fired prior to the start of the International Geophysical Year; an additional 200 were fired as part of the International Geophysical Year program. Current rate of rocket soundings is somewhat below 100 per year. Higher altitude rockets are being introduced into the work to extend the atmospheric observations to one to several thousands of miles altitude.

Launchings have been carried out at White Sands, N. Mex.; Wallops Island, Va.; San Nicolas Island, Calif.; Cape Canaveral, Fla.; Fort Churchill, Canada; Guam; and from shipboard in the North Atlantic, the mid-Pacific and South Pacific, and the vicinity of Antarctica.

The U.S. program has produced hundreds of research papers and reports giving results on the pressure, temperature, density, winds, and composition of the upper atmosphere, the ionosphere; the earth's magnetic field; the aurora and airglow; cosmic rays; micrometeors; solar radiations; and ultraviolet astronomy. Some experiments have been carried out on modifying the upper atmosphere by the release of special chemicals, and on modifying the radiation belt by nuclear explosions. Some bioscience experiments have been performed.

The U.S.S.R. has also been carrying out a rocket sounding program since the last war. Although the precise number of rocket soundings to date is not known, they number in the hundreds. Firings have been made from Franz Josef Land and from Mirny in Antarctica, as well as from European U.S.S.R. The Soviets have perfected a meteorological sounding rocket that is used for more or less routine soundings of the atmosphere to measure air pressures, densities, and temperatures up to 35 miles altitude. In addition, their "geophysical rocket" is capable of carrying ton and a half payloads up to 300 mile altitudes.

From their sounding rocket program the U.S.S.R. has obtained a broad collection of results. The meteorological soundings have produced detailed data on the structure of the upper atmosphere just above the troposphere, showing its temporal and seasonal variations. The geophysical rocket program has provided considerable information on the very high atmosphere, including the ionosphere. The description of one of the geophysical rocket payloads is so similar to the description of Sputnik III and its instrumentation as to lead one to conjecture that the payload may have been essentially the Sputnik III payload. Whether or not this is the case, the instrumentation provided for a broad range of measurements on the ionosphere, atmospheric structure, energetic particles, and the earth's magnetic field. The U.S.S.R. rocket program has also included considerable work on biological researches. There have been some 20 tests in which dogs, and/or rabbits were sent aloft and recovered for study. During the flight the behavior of the animals was telemetered to ground.

The U.S.S.R. launched the first successful artificial Earth satellite. To date the U.S.S.R. has successfully launched three Earth satellites, and three space probes. Two of the space probes achieved Earth escape velocity; the first passed within 2 or 3 Moon diameters of the Moon. The second Soviet space probe actually hit the Moon. The third space probe was launched so as to pass close enough to the Moon to take pictures of the unseen side of the Moon's surface, then to loop around the Moon returning to the Earth. The lunar pictures were successfully obtained.

The United States has to date successfully launched 15 Earth satellites; namely 5 Explorers, 3 Vanguard, Project Score, and 6 Discoverers; and 3 space probes, all called Pioneers. Only one of the space probes achieved Earth escape velocity, passing by the Moon at some 37,000 miles distance.

Both the United States and Soviet satellites and space probes have produced valuable scientific results. Included are some spectacular discoveries and achievements, some of which are given in the accompanying table No. 1. In addition to the more spectactular output, these satellite and space probe flights are turning out a steady flow of information and results that build up gradually to an impressive advancement of mankind's knowledge of the Earth and outer space. Some of these are listed in table 2.

PROBLEMS BEING ATTACKED

In attempting to compare the relative stages of advancement of the United States and U.S.S.R. in space research, one might proceed by trying to list item by item the individual results from the two programs and to relate these results item to item. This would turn out to be difficult even if one were sure that all the results obtained by the Soviets were actually at hand, for there would be many observations obtained by the Russians that had not yet been obtained by the United States, and conversely, many obtained by the United States that had not yet been obtained by the Russians. A more effective, and perhaps more significant way of comparing the relative stages of advancement, would be to isolate the general areas of the investigation and the general problems being attacked by the two countries.

Taking this approach one can say that the United States and the U.S.S.R. appear to be at about the same stage of advancement in upper air research. The U.S. results on the atmosphere below 200 miles appear to be more detailed and complete, but the Soviets have made higher altitude measurements by means of their geophysical rocket. The Soviets appear to have done far less than the United States on solar radiations, but the U.S.S.R. has done much more than the United States on biosciences experiments, having conducted numerous flight tests in which dogs were carried aloft in rockets and safely recovered. The U.S.S.R. has carried the technique of ejecting instrumented packages from the rocket carrier farther than has the United States, which has carried the technique of telemetering to a high degree of refinement.

Likewise, the United States and the U.S.S.R. seem to be at about the same stage of advancement in studies of the Earth's environs where satellite techniques are adequate for making the necessary observations. In fact it may be that in this regard the United States has the slight edge. The big advantage the Soviets have in attacking these problems lies in their greater payload capacity. On the other hand, the United States has launched many more satellites than the Soviet Union.

In deep space probe work the U.S.S.R. has definitely taken the lead. This is directly attributable to their clear lead in vehicle technology.

Table 3 provides a comparison of the states of advancement of the United States and the U.S.S.R.

A review of table 3 shows fairly clearly that the United States and the U.S.S.R. scientists are at about equal stages of advancement in the problems they are attacking or are about to attack in space research. As groups they undoubtedly have comparable competencies and understandings of the significant problems that ought to be tackled. Their instrumentations are roughly equivalent, although the United States may have a slight edge here, as indicated by the fact that the U.S.S.R. quite often simply copies U.S. equipment for its own instrumentation. The conclusion follows then that the side that has the more advanced technology in the way of payload capabilities, guidance, etc., will have the distinct edge and by virtue of the increased flexibility and capabilities provided by the more advanced technology will forge steadily ahead. Thus, one may predict a time lead in vehicle technology will be transformed into a corresponding time lead in the exploration and investigation of outer space.

TABLE 1.—*Significant firsts in sounding rocket, satellite, and space probe research*

United States

1. A number of firsts in high altitude rocket research, including among others:
   - First detailed photo of solar ultraviolet spectrum.
   - First photo of complete tropical storm.
   - First penetration of equatorial ionospheric current sheets.
   - First detection of X-rays in high atmosphere.
   - First detection of auroral particles in high atmosphere.
2. Discovery of the Van Allen Radiation Belt.
3. Discovery that the Van Allen Radiation Belt consists of at least two zones.
4. Performance of the Argus experiments.
5. The first precise geodetic use of artificial Earth satellites (Vanguard I) to obtain refined information on the size and shape of the Earth, providing an improved value for the flattening and showing that the Earth is actually slightly pear shaped.
6. First achievement of an elementary communication satellite, in Score.

U.S.S.R.

1. First artificial Earth satellite.
2. First lunar near miss.
3. First lunar impact.
4. First pictures of the hitherto unseen side of the Moon.
5. First detection of what may be a current ring about the Earth (the Chapman-Størmer ring).
6. First routine recovery of large animals (dogs, and rabbits) from high altitude rocket flights.
7. Development and routine use of a meteorological sounding rocket, recoverable and reflyable.
8. First launching of a large animal (Laika) in a satellite of the Earth.
9. First high capacity, maneuverable, heavily instrumented, spacecraft with fully successful long range communications (Lunik III).

TABLE 2.—*Sounding rocket, satellite, and space probe results*

Field	United States	U.S.S.R.
Upper atmosphere	1. Rocket observations have been made of pressure, temperature, density, composition, and winds of the high atmosphere at a wide variety of locations, both day and night, and in the various seasons.	1. Rocket observations have been made of pressure, temperature, density, composition, and winds of the high atmosphere at a wide variety of locations, both day and night, and in the various seasons.
	2. Upper air densities have been obtained from the tracking of both United States and U.S.S.R. satellites.	2. Upper air densities in the higher latitude regions obtained from drags on Sputniks I and III.
	3. It has been shown that the radiation belt may account for much higher atmospheric temperatures observed in the auroral zone atmosphere than in the high atmosphere above the middle and equatorial regions.	3. High enough flux of low-energy electrons measured with Sputnik III instruments in the northern regions to account for the higher atmospheric temperatures there.
	4.	4. Direct measurement of upper air densities made with gages in Sputnik III, for heights up to 355 km.
	5. Fluctuation in satellite drag, hence presumably upper air densities, have been shown, from observations on Vanguard I and Sputnik II, to be directly correlated with fluctuations in the 10-cm. radiation from the sun, and hence solar activity.	5.
	6.	6. The routine meteorological sounding rocket has been used to give atmospheric structure data at middle-European, Arctic, and Antarctic locations, showing seasonal variations as well as geographic. It turns out that the seasonal variations are different for the different altitude ranges.
	7. From both satellite and rocket observations, high-altitude air densities have been shown to vary widely with time of day, season, and geographic position.	7.
	8. The amounts of diffusive separation both below and above the E region of the ionosphere have been measured in sounding rocket experiments, and shown to be very slight below the E region and quite pronounced above altitudes of 110 to 120 km.	8. Diffusive separation in the upper atmosphere below the E region has been measured with results that agree in general with the U.S. observations.
Ionosphere	1. Extensive electron density data have been obtained for a number of locations from rocket soundings.	1. From rocket soundings, electron densities have been obtained up to and above the F region maximum.
	2. From radio signals of both United States and U.S.S.R. satellites, propagation characteristics of the ionosphere and electron density distributions have been obtained.	2. Electron densities above 300 km. were obtained by observation of the radio signals of Sputniks I and III.
	3.	3. Observations on Sputnik I showed 3.5 times as many electrons above the F region maximum as below.
	4. The heavy ions in the ionosphere above White Sands and Fort Churchill have been identified up to the F region in rocket sounding experiments.	4. The ionic composition of the ionosphere has been measured in sounding rockets to above the F region maximum.
	5.	5. Sputnik III observations showed that the predominant ion from 250 to 950 km. is positive atomic oxygen, $O+$.
	6.	6. In Sputnik III the satellite potential in the daytime ionosphere was observed to be as much as -7 volts.
	7. Very low frequency propagation data were obtained from Explorer VI.	7.
	8.	8. In the second lunik, evidence of a lunar ionosphere was obtained.

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Magnetic Field	1. Data on earth's magnetic field were obtained from Pioneer I and Explorer VI, and a great deal of additional high quality data are being obtained from Vanguard III.	1. Data on earth's magnetic field obtained from Sputnik III.
	2. By their magnetic effect, electric current flows were plotted in the E and lower F regions, in rocket sounding experiments in the equatorial regions.	2.
	3.	3. On mechta measurements were made of the earth's magnetic field and its extension into space. A marked dip in the field was discovered in the region of the radiation belt, indicating perhaps the existence of a current ring such as postulated by Chapman.
	4. Rocket measurements of the earth's magnetic field have been made in the auroral regions.	4.
	5.	5. Lunik II, on its plunge to the surface of moon, showed that the lunar magnetic field is not greater than 50 gamma.
Cosmic Rays	1. Extensive data on cosmic ray intensities, composition, and interactions with matter were obtained from sounding rockets in various locations and throughout all the seasons.	1. Cosmic radiation measurements have been made in U.S.S.R. sounding rockets.
	2. The cosmic ray count was obtained above the atmosphere with counters in Explorer satellites and Pioneer probe.	2. The cosmic radiation was measured in Soviet satellites and space probes.
	3. Cosmic ray counts in the first Explorers gave discovery of the radiation belt.	3. Sputnik II observations showed an increase in counting rate with height (this being at the time, an unrecognized hint of the presence of the radiation belt).
	4. Details on the cosmic radiation as a function of time and position in space have been obtained from Explorer VI, and are being obtained from Explorer VII.	4. Sputnik III and cosmic rockets provided measurements on the heavy nuclei in the cosmic radiation.
Radiation belt	1. Radiation belt discovered with instruments in Explorer I	1. Abnormally high cosmic ray counts were observed in Sputnik II, particularly at the high latitudes. Sputnik III showed a very high electron flux in the northern latitudes.
	2. A great amount of additional detail obtained on belt in Explorers III and IV, and the Pioneer probes. Extent of radiation belt shown by Pioneer I. Pioneer III showed belt to consist of at least 2 zones.	2. Sputnik III, mechta, and other Soviet satellite and space probe observations confirm the U.S. findings.
	3. Pioneer IV showed the extent of the outer radiation belt to have increased greatly following a 5-day period of high solar activity, thus proving that the outer belt is of solar origin.	3.
	4. Argus experiments showed individual inner zones of the radiation belt to be very stable.	4.
	5. Argus observations lends support to conclusion that inner radiation belt produced by cosmic rays. See No. 7 below.	5.
	6. Detailed energy spectrum of radiation in radiation belt was obtained by Explorer VI.	6.
	7. Sounding rocket observations showed that the energetic particles of the inner radiation belt are protons of energy spectrum expected from β decay of neutrons, hence supports cosmic ray origin for hard components of inner belt.	7.
	8. Extensive additional information on the radiation belt was obtained from Explorer VI and is being obtained from Explorer VII and Vanguard III. Huge variations of many orders of magnitude in counting rates were observed in outer zone.	8.

TABLE 2.—*Sounding rocket, satellite, and space probe results*—Continued

Field	United States	U.S.S.R.
Radiation belt—Continued	9. Radiological hazard of radiation belt estimated to be not serious for a direct traverse of the belt, but quite serious for a space station that spends a lot of time in the belt.	9. Radiological hazard of radiation belt estimated to be not serious for a direct traverse of the belt, but quite serious for a space station that spends a lot of time in the belt.
	10. ----------	10. The moon was shown not to have a radiation belt detectable within the sensitivity of lunik instruments.
Aurora	1. Rocket soundings have been used to study the electromagnetic and particle radiations in the aurora. It was found that soft radiation flux above 40 km. was many times the primary cosmic ray count.	1.
	2. ----------	2. A very high flux of low-energy electrons was observed in Sputniks II and III. This flux was taken to be the cause of the very high atmospheric temperature in these regions.
	3. The particles in the outer radiation belt have been shown to be the likely immediate cause of the aurora.	3. The particles in the outer radiation belt have been shown to be the likely immediate cause of the aurora.
Geodesy	1. Vanguard I observations give an oblateness of the earth of 1/298.3	1.
	2. Vanguard I observations show the earth to be pear shaped with a 50-ft. peak at the North Pole, and a 50-ft. flattening at the South Pole; this appears to imply an internal strength to the earth, rather than a free-flowing plasticity.	2.
Meteors	1. A fairly low count of micrometeors corresponding to a total influx of 1,000 to 10,000 tons of material per day, from Explorer and Pioneer observations.	1. Influx of material per day indicated by Sputnik III observations in general agreement with the U.S. results.
	2. A very large amount of additional data are being obtained from the Vanguard III instrumentation.	2. Additional measurements made in Soviet cosmic rocket flights.
Astronomy	1. In sounding rocket experiments, ultraviolet sources in the sky have been detected and plotted.	1.
	2. The solar spectrum has been observed and photographed down to 303 angstroms.	2.
	3. Solar radiations have been observed and measured in the X-ray regions.	3.
Lunar explorations	1. ----------	1. First photos taken of the hitherto unseen side of the moon.
	2. ----------	2. The lunar magnetic field shown to be no greater than 50 gamma.
	3. ----------	3. Lunar ionosphere detected.
Miscellaneous experiments	1. The Argus experiments were carried out	1.
	2. Sodium vapor was released in the high atmosphere and observed to measure its radiations, atmospheric winds, and diffusion.	2. Sodium clouds were released from Luniks II and III and observed from the ground.
	3. Various chemical contaminants were released in the high atmosphere to study the photochemical reactions that resulted.	3.
Biosciences	1. On numerous sounding rocket flights, biological specimens of seeds, fruitflies, etc., have been flown and recovered for study. Larger animals, such as rats and monkeys, have been flown for study of their behavior and the effects of the flight environment on them. Recovery of such animals has been effected on numerous occasions.	1. Large numbers of sounding rocket experiments have been carried out with dogs and rabbits, in which the animals were both studied during flight and recovered after flight for further study.
	2. ----------	2. Observations were made on the behavior of Laika, particularly heartbeat and respiration, in Sputnik II.
Engineering data	1. U.S. satellites show that moderate temperatures can be achieved in orbiting vehicle.	1. U.S.S.R. satellites and space probes show that moderate temperatures can be achieved by appropriate engineering.
	2. Elementary communications link checked out in Project Score	2.
	3. Based on radiation belt data, it is deduced that satellites may charge to a potential of some hundreds of volts in the radiation belt.	3. Sputnik III measurements show that in the daytime ionosphere the satellite acquired an appreciable negative charge corresponding to a

	3. Based on radiation belt data, it is deduced that satellites may charge to a potential of some hundreds of volts in the radiation belt.	3. Sputnik III measurements show that in the daytime ionosphere the satellite acquired an appreciable negative charge corresponding to a negative potential of several volts.
	4. The meteor erosion and puncture problems have been shown in general to be not particularly serious.	4. The meteor erosion problem appears to be not particularly serious.
	5. An elementary TV scanner was checked out in Explorer VI, while some of the basic elements of a meteorological satellite were checked out in Vanguard II.	5.
	6. ----------	6. Automatic photography of the moon and the televising of the photographs obtained back to earth has been achieved.
	7. Solar cells have been shown to be a practical, reliable source of power.	7. Solar cells have been shown to be a practical, reliable source of power.
	8. ----------	8. A complete spacecraft, maneuverable, with temperature control, power supply, long-range communications link, complicated instrumentation, etc., has been engineered and flown successfully; namely, Lunik III.
	9. It appears that the radiological hazard to space-vehicle crews traversing the radiation belt directly may be relatively low, while the hazard to those in a satellite orbiting through the radiation belt would be quite serious. In addition, marked increases in proton intensiti of the cosmic radiation found at the time of solar activity may be a very serious radiological hazard: dose rates of 1,000 roentgens per hour.	9. It appears that the radiological hazard to space-vehicle crews traversing the radiation belt directly may be relatively low, while the hazard to those in a satellite orbiting through the radiation belt would be quite serious.
Meteorology	1. Numerous sounding rocket photos of cloud formations and si nificant weather areas have been taken. In particular, a composite photo from 1 sounding rocket showed a completely developed tropical storm approaching hurricane proportions.	1.
	2. ----------	*2. A meteorological sounding rocket was developed and has been used on a routine basis for meteorological studies.
	3. ----------	3. Detailed measures of pressures and temperatures have been obtained with the meteorological rocket for Antarctic, Arctic, and middle European locations.
	4. Cloud picture data were obtained in Vanguard I, but motions of the satellite have so far prevented reducing the data to useful pictures. Also, very low resolution, elementary television pictures have been taken of cloud formations as seen from Explorer VI. One of these pictures was assembled and released.	4.

TABLE 3.—*Problems currently under attack*

Field	United States	U.S.S.R.
Upper atmosphere	1. A detailed study of the structure, winds, and composition of the ionospheric regions and beyond in the earth's atmosphere is underway by means of sounding rockets and earth's satellites. 2. Work is underway to develop a routine rocketsonde for synoptic studies of the lower portion of the upper atmosphere in association with meteorological soundings.	1. A detailed study of the structure, winds, and composition of the ionospheric regions and beyond in the earth's atmosphere is underway by means of sounding rockets and earth's satellites. 2. The U.S.S.R. has already achieved the development of a routine rocketsonde for meteorological-type soundings into the lower portion of the upper atmosphere.
Ionosphere	Intensive rocket and satellite studies of the ionosphere in the F region and beyond are underway.	Intensive rocket and satellite studies of the ionosphere in the F region and beyond are underway.
Magnetic field	The United States has used search coils, saturable core magnetometers, and proton precession magnetometers in its measurements of the earth's magnetic field. The United States is preparing to use a much more sensitive instrument, the alkali vapor resonance magnetometer, for further studies of magnetic fields in space and to measure the magnetic field of the moon.	The U.S.S.R. has also used standard-type magnetometers and proton precession magnetometers for observations of the earth's magnetic field. The U.S.S.R. has made a measurement to detect the lunar magnetic field, finding none to within the sensitivity of their instrument. It is not known whether the U.S.S.R. is preparing to use the alkali vapor magnetometer in the near future.
Cosmic rays	Balloon, sounding rocket, and satellite observations of the intensity, nature, and effect of cosmic rays are underway.	Balloon, sounding rocket, and satellite observations of the intensity, nature, and effect of cosmic rays are underway.
Radiation belt	Detailed study of the radiation belt by means of sounding rockets, satellites, and space probes, with occasional use of controlled experiments, is underway.	The U.S.S.R. made intensive studies of the radiation belt in Sputnik III, but at the present time appears to be investigating the belt incidentally as part of their concentration on deeper space missions; namely, on their lunik flights.
Aurora	U.S. scientists are tackling the problem of both visible and ultraviolet auroral radiations, the particles connected with the aurora, and the ultimate origin of the aurora.	The U.S.S.R. scientists are tackling the same problems.
Geodesy and celestial mechanics.	United States is continuing use of satellites for geodetic studies	The U.S.S.R. shows skill in applications of celestial mechanics, as witnessed by their ability to launch Lunik III with the accuracy achieved, and to predict the motions of the Lunik III spacecraft.
Meteors	The United States continues to collect data on meteors in space, using a wide variety of experimental equipments.	The U.S.S.R. has made an intensive study of micrometeors in their satellites and space probes, appearing to attack the general problem very much along the lines followed by the United States.
Astronomy	Active rocket astronomy in being. Orbiting telescopes, solar, and astrophysical observatories being worked out.	Unknown.
Lunar exploration	The United States is preparing to conduct intensive investigations of the moon, but the actual observation of the moon from space vehicles is yet to begin.	The U.S.S.R. has already achieved significant steps in its investigation and study of the moon. It may be presumed that the Soviets will continue their vigorous efforts in this area.
Planetary investigations	United States has minimal capability in this area at present, and on the present schedule planetary work is proceeding at a very low pace.	The U.S.S.R. has an advanced capability in this area, and has declared its definite interest in planetary research.
Miscellaneous experiments	United States using upper atmosphere regions for controlled chemical and Argus type experiments. Also planning relatively and gravity experiments.	Unknown.
Biosciences and man in space	The United States has a 1st-stage, man-in-space program in project Mercury. Support work of a research type is being carried out in the Discoverer program. Some experimental work is being carried out in sounding rocket flights. A well-rounded, fully developed program of research in both biotechnology and biosciences is yet to be worked out.	The U.S.S.R. has a highly active program of research on animals under rocket flight and satellite conditions. It is not known how fully developed their biotechnical and fundamental biosciences programs are. It is expected, particularly from recent news releases, that the U.S.S.R. does have a man-in-space program.
Meteorology	The United States is developing rocket photographic techniques for meteorological purposes. The United States is developing a meteorological sonde for synoptic soundings. The United States is conducting fundamental satellite experiments associated with meteorology,	The U.S.S.R. has already developed a working meteorological rocket sonde, which they have already put to extensive use. It is not known what the U.S.S.R. is doing in the matter of developing a satellite meteorological system.

	logical sonde for synoptic soundings. The United States is conducting fundamental satellite experiments associated with meteorology, and is taking the initial steps in the development of a meteorological satellite system.	what the U.S.S.R. is doing in the matter of developing a satellite meteorological system.
Communications	In its rocket, satellite, and space-probe telemetry the United States has shown good capability. Long-range communication systems are being worked on for deep-space probes. Communication satellite systems are being worked on.	The U.S.S.R. rocket, satellite, and space-probe telemetry has been successful. In particular, the communications and telemetry problems of Lunik III appear to have been worked out with a high degree of competence. It is not known whether they are developing a communication satellite system, but it may be presumed that they are.
Navigation	The United States is working on a navigation satellite of high degree of refinement.	It is not known whether the U.S.S.R. is devoting effort to a navigation satellite.

NOTE.—Since the publication of Dr. Newell's paper, the United States has had 3 highly successful experiments.

On March 11, 1960, Pioneer V was launched into an elliptical orbit between the Earth and Venus. As of April 15, 1960, it was still transmitting data from a distance of 4,716,000 miles. All long-distance communication records have been broken by this space probe and it is expected to send useful data back from as far out as 50 million miles.

On Apr. 1, 1960, Tiros I, the world's first successful meteorological satellite, was launched into an almost perfect 450-mile altitude orbit. It is sending back a veritable flood of spectacular pictures of cloud covers that presage a revolution in the science of meteorology.

On April 13, 1960, the Transit I–B was successfully launched but with the orbit slightly more elliptical than planned. This navigational satellite is expected to be operational in 1962 under the direction of the U.S. Navy, but with far-reaching implications for civilian use in aircraft and ships.

Senator YOUNG. May I ask, Dr. Glennan, that completes your prepared statement?

Dr. GLENNAN. It does, Senator Young.

Senator YOUNG. And in that connection, I want to say that it appears to me that that was a very clear-cut statement indeed, and very encouraging. The members of the subcommittee will proceed to ask you some questions. That will enable you to supplement your statement as you may wish.

May I ask, Senator Smith, will you proceed first?

ATLAS HAS NOT YET BEEN FULLY EXPLOITED

Senator SMITH. Thank you, Mr. Chairman.

Dr. Glennan, on page 3 of your statement, you say,

> **Practically all of our launchings have employed the 150,000 pound thrust Thor and Jupiter rockets. In only three experiments has the United States employed the higher thrust Atlas, and in no single case involving the use of any of these rockets, as first stage boosters, have we been able fully to exploit the thrust capability of the rocket. Even today, we must continue to use as upper stages in those systems rockets available from other programs which have been modified and adapted for that purpose.**

Would you explain further what you mean by the reference to our inability to exploit fully the thrust capability of the Thor, Jupiter, and Atlas rockets, what we are doing about this?

Dr. GLENNAN. I would be very happy to do that, Senator Smith. It is simply the fact that we have not had available to us rockets of the right size, the right thrust capability, to fully exploit the thrust of the first stage booster rocket, the Atlas or the Thor or the Jupiter. For instance, in the Thor–Able, which is a launch vehicle based on the Thor booster rocket of 150,000 pounds thrust, we have had available to us the second stage of the Vanguard, and the third stage of the Vanguard. We put these together to make the Thor–Able launch vehicle. But to get the most out of that first stage, we must wait until we get the Agena B, which, very fortunately, will be available in a very few months. Actually, I think what we are saying is that we have taken the IRBM's, the ICBM's, and we have put on top of them for immediate use those rockets which were readily available to us, while we have been going ahead with the business of designing and developing and producing properly proportioned rockets.

The Agena B is the first stage which will be available to us to exploit the Thor rather fully. It will improve very much the capability of the Atlas. But it will not be until we get the Centaur stage that we will fully exploit the capability of the Atlas.

Senator SMITH. Doctor, what is being done to expedite results on Centaur?

Dr. GLENNAN. Centaur, I think, is going along very well indeed. I think there is no reason to worry about the pace on this. We have one unanswered question, which, if we fail to get the right answer, we would be a little bit limited in the number of different kinds of missions that the launch vehicle system could undertake. But we have confidence that by mid-1961 the Centaur will be a working system.

DEVELOPMENT OF THE NOVA CONCEPT

Senator SMITH. Dr. Glennan, on page 5, you refer to the Nova vehicle as having a total thrust of 6 to 10 million pounds. At our hearings last year, the Nova was described as a vehicle which clustered four F–1 engines together, 6 million pounds of thrust. Would you please explain this change in concept?

Dr. GLENNAN. I am very happy to do that, because I am sure that we have added to the confusion about the Nova vehicle.

In our sense of urgency to get ahead with this program, we moved to a vehicle concept before we really should have. The Nova is still just a concept. There has not been designed a rocket system which will use the F–1 engine. The F–1 engine is the 1½-million-pound-thrust engine which is being developed under contract by the Rocketdyne Division of North American Aviation.

One million and a half pounds of thrust in a single chamber can be clustered, as the Saturn vehicle is being clustered, so that one has, say, four of those million and a half pounds, to get 6 million pounds of thrust, or six of them to get 9 million pounds, or eight of them to get 12 million pounds. Each one of these systems would require a different vehicle configuration. Until we have more realistic information on the development results of the F–1 engine, it is really not too useful to go beyond conceptual studies of the design of the vehicle configuration. We will have time, when we know that the engine is really going down the line well—and it seems to be thus far—we will have time to design this. As a matter of fact, I think studies are starting this year, are they not?

Mr. HORNER. Yes, sir.

PROJECT MERCURY PROGRESS

Senator SMITH. One of the charts you have shown us indicates that the first manned orbital flight for Project Mercury will take place late in 1961, while the first suborbital flights of the astronauts are scheduled for later this year. Last year you were reluctant to discuss publicly any timetable for Project Mercury. Have you made any change in your policy on that score?

Dr. GLENNAN. Not really, Senator Smith. I think that we are willing to say that things are going along well enough so that we believe that at some point, before the end of this year, we can undertake, with reasonable assurance, a suborbital flight. And, again, as we look down the road, the progress being made by the project is such that it does appear that if things go well, the orbital flight is a reasonable possibility before the end of calendar 1961. We will not pinpoint any dates, Mrs. Smith. We must continue to say that when we have been satisfied that all of the elements of this system are operating properly—give a reasonable degree of reliability, give us the assurance that we want—then we will go.

The astronauts, I am sure, would like to go now. I just don't think this is wise in a program of so much importance as this.

Senator SMITH. You are satisfied with the progress, with the feeling that this will come about before the end of this year?

Dr. GLENNAN. I am, Mrs. Smith. I am never satisfied with progress. But I think that all things considered the effort that is being made on this is being wisely placed, that the pace is as rapid as one should require, in light of the importance of success in this project.

Senator SMITH. Last year, Mr. Low was quoted as follows, and I quote:

> We will not send a man on the Mercury mission until we are convinced that the mission will be no more dangerous than certainly a normal test-flying-type operation.

Is that still your policy?

Dr. GLENNAN. I think this is a way in which we all attempted to rationalize our viewpoint. I think it is perhaps a little more accurate to say that we want to be assured that all of the systems and the subsystems are working reliably. If that is the case I am sure that the astronaut is going to have no problem greater than that of a test pilot taking up a high-performance aircraft for the first time.

$12 TO $15 BILLION TO BE SPENT ON SPACE IN NEXT DECADE

Senator SMITH. On page 10, Dr. Glennan, you indicate that the NASA 10-year plan would involve the expenditure of $12 billion to $15 billion in the next decade. Will you tell the committee what we will get for that large expenditure?

Dr. GLENNAN. You will get leadership in the space field, for one thing. I think you will get—the Nation will regain the confidence of the entire world in the quality of leadership, scientific competence, that have so long characterized our standing as a nation.

In the more practical sense, I believe we will have, within that decade, working systems in the meteorological field, where I believe the economic payoff is going to be interesting.

If we do—if we are successful in the meteorological field, I think the payoff in international relations is going to be tremendous, because this is the kind of an activity in which every nation must ultimately participate, and from which every nation will benefit.

It is highly probable, also, that by the end of the decade, working communications systems will be available to us. These, I think, have economic value.

Finally, this total business of acquiring new knowledge ought to give us the same kinds of results that we have had in the past, from similar activities conducted in other environments.

I suspect that I am leading a little with my chin, but I do believe that this field of space research and development may have as much to do with providing a mechanism for really getting at working relationships with the other nations in the world, developing a real climate of international good will, as almost any other process we are undertaking at the present time.

All of that says to me it is worth it.

HIGHEST PRIORITY ENJOYED BY SATURN AND MERCURY

Senator SMITH. Doctor, on page 11, you state that both of your two highest priority programs, Saturn and Mercury, enjoy a DX priority rating. Please explain briefly now and provide a more complete statement for the record, if you will, exactly what a DX priority rating is, and who authorizes it, and what it really accomplishes.

Dr. GLENNAN. We will be glad to provide a rather complete statement for the record.

Just briefly, the DX priority rating is a rating which is approved—it is approved by the President. It is the highest rating in the land. It is enjoyed by a few of the ballistic missile programs in the Defense Department, by, I think, two of their space projects—and by these two of ours. And only these programs have the DX priority rating.

It actually provides a means for us to get scarce materials, and accelerated shipping dates, things of this sort, as against any other programs in the land.

Senator SMITH. Doctor, when were the two projects given the DX priority?

Dr. GLENNAN. The Mercury was given in April of 1959, and the Saturn was given in January of this year.

Senator SMITH. What other Government programs enjoy DX priority? Any?

Dr. GLENNAN. As I say—may we supply that for the record? There are these particular Defense Department programs. I want to take a little look at the security.

Senator SMITH. You will include that in your overall statment?

Dr. GLENNAN. We will.

(The information is as follows:)

THE NATIONAL PRIORITY SYSTEM

The President has established a national industrial priority system under the authority of the Defense Production Act, to control the acceptance and performance of contracts, and the allocation of materials and production facilities. The Business and Defense Services Administration, under the Department of Commerce, administers this system. The industrial priority system has two categories: DX and DO.

The DX rating is authorized by the BDSA for programs, projects, and items which have been declared by the President to be of the highest national priority.

A DO rating is authorized for programs, projects and items necessary or appropriate to promote the national defense, but not of such urgency as to require a DX rating. The Defense Department has been authorized to assign a DO rating to all of its programs. Similarly, NASA has been authorized to assign a DO rating to all of its programs.

The purpose of the national priority system is to insure that performance under contracts or orders necessary or appropriate to remote the national defense takes priority over performance under other contracts or orders. It assures the unimpeded flow of materials, equipment, and supplies necessary to secure such performance. Priority does not govern budgeting or allocation of funds by the Bureau of the Budget or the agencies of the Government.

The Department of Defense, the NASA, and the AEC are the only agencies of the Government having projects for which DX priority ratings have been authorized. The DX priority list is maintained by the Department of Defense and is classified "Secret."

OVER TWO YEARS SINCE PREPAREDNESS SUBCOMMITTEE RECOMMENDED PROMPT DEVELOPMENT OF LARGE BOOSTER

Senator SMITH. In view of the unanimous recommendations of the Preparedness Subcommittee over 2 years ago, for prompt development of a rocket motor with a million pound thrust, why did it take so long to give this superbooster a high priority?

Dr. GLENNAN. Well, I am not certain that I can answer wholly on that. We moved into this activity very rapidly, once NASA came into being, on October 1, 1958. Prior to that time, we had had no responsibility for it.

With respect to the F–1 engine, we solicited bids on it in October 1958 and actually signed the contract in January 1959. Shortly after we took over the project, on November 14, 1958, to be exact, we asked the Department of Defense to include the F–1 engine in their DX priority requests. Subsequently, we and the Department of Defense in consultation with the National Aeronautics and Space Council decided not to pursue the request for DX priority for the F–1 project because the nature of the program was such that it was not likely to benefit from this priority at this early stage of its development.

We did decide with the assistance of the Department of Defense to monitor this program on a continuing basis to be sure this decision remained a wise one. There has been no evidence since that time that the program has been delayed by the lack of the DX priority.

Moreover we would not hesitate now or at any time in the future should the need arise to ask for such a priority for the program.

Perhaps you are referring to the million-and-a-half-pound thrust Saturn vehicle. During the early stages of its development it was the responsibility of the Defense Department and, although it enjoyed a high priority, there seemed to be no military requirement that would call for the highest national priority. However, once the Saturn program became a NASA responsibility, we moved promptly to obtain such a priority—and it was assigned in January of this year. (Further clarification concerning priorities appears on p. 564.)

Senator SMITH. Mr. Chairman, I think my time is up. But without taking the time of the subcommittee, I have some questions that I would like Dr. Glennan to answer for the record. These questions have to do with the new Office of Life Sciences, which is not shown on the latest NASA organization chart which was submitted to this subcommittee in preparation for these hearings. So if we can have these questions answered for the record, I would appreciate it.

Dr. GLENNAN. I would be happy to do that.

(The information is as follows:)

QUESTIONS ANSWERED FOR THE RECORD CONCERNING NASA'S NEW OFFICE OF LIFE SCIENCES

MEMORANDUM FOR THE SENATE COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES ON FISCAL YEAR 1961 AUTHORIZATION

1. On March 1, 1960, NASA announced the establishment of an Office of Life Sciences as the fifth major office of NASA and the appointment of Dr. Clark T. Randt (M.D.) as its Director.

Would you please tell the committee of some of the background that served as a basis for the establishment of this new Office?

In accord with the mandate given the National Aeronautics and Space Administration in the Space Act of 1958, concerning "activities in space devoted to peaceful purposes for the benefit of all mankind" it is appropriate that the study

of life processes in this new environment should constitute a significant part of the total effort.

Manned space flight and exploration are conceived to utilize man's unique capabilities for selecting and making a wide variety of unprogramed observations. for his ability to react intelligently to unanticipated situations, and for his resourcefulness and manual skill in servicing the complicated mechanisms of space vehicles in flight. These are indispensable contributions to the successful execution of space missions and to obtaining maximal scientific information not only related to biological problems but to the physical sciences as well.

The leadtime for necessary advances in biotechnology, which include man-machine integration, definition of tolerance of combined environmental stresses, development of life-support systems, and provision of adequate protective and escape devices requires a continuing vigorous effort.

Research designed to acquire basic medical and behavioral information relevant to meeting the physiological and psychological needs for long-term existence and effectiveness in stressful, artificial environments will necessitate augmentation of investigations in metabolism, respiratory physiology, cardiovascular physiology, neurophysiology, and psychology.

Basic biologic studies concerning the effects of space environments on living organisms and the search for extraterrestrial life anticipate investigation of molecular control of cellular activity and of comparative biology on the broadest possible scale. Exposure of living cells and tissues to a broad range of ionizing radiation, weightlessness, low pressures, extremes of temperature, and unusual compositions of remote planetary atmospheres and surfaces opens a new window for observation of hitherto unexplained biologic phenomena. This research will bear upon such basic problems as the origin of life and the genetic mechanisms of evolution which will undoubtedly contribute to a better understanding of the fundamental laws of nature. Although these studies will be an outgrowth of continuing ground-based investigations, the space environment provides a new laboratory which cannot be duplicated on earth.

Recognition of these objectives gave rise to the appointment of the Bioscience Advisory Committee by NASA Administrator T. Keith Glennan in July 1959. The membership of this Committee was selected on the basis of the generally recognized stature of the individuals rather than prior interest in the national space program. It was chaired by Dr. Seymour S. Kety, Director of the Clinical Science Laboratory of the National Institutes of Health, and included Dr. Wallace O. Fenn, professor of physiology, University of Rochester; Dr. David R. Goddard, director of the division of biology, University of Pennsylvania; Dr. Donald G. Marquis, professor of psychology, Massachusetts Institute of Technology; Dr. Robert S. Morison, director of natural and medical sciences, the Rockefeller Foundation; and Dr. Cornelius A. Tobias, professor of medical physics, University of California.

The Bioscience Advisory Committee was apprised of aerospace medical facilities, programs, and personnel by 17 representatives of the Army, Navy, and Air Force, who comprehensively covered activities in this area. Representatives of industry and universities also provided background information for the Committee. Their report was submitted to Dr. Glennan on January 25, 1960, and its contents are now available to all those who are interested in this phase of the space program. This document reflects the considered opinion of six eminent individuals regarding the role of biology, medicine, and psychology in the NASA program. The recommendations have provided overall guidelines for the Office of Life Sciences which will be useful in further planning and development of the life-science programs.

The committee was well aware of the excellent contributions being made by the military aviation medical laboratories and the desirability of avoiding unnecessary duplication in this area. Important as the aviation medical contributions have been and will continue to be, additional opportunities in biology, medicine, and psychology are being presented in these fields related to the expanding space effort on a long-range basis. It is the purpose of the NASA Office of Life Sciences to augment the outstanding work of the military aerospace laboratories in order to provide basic contributions in space exploration.

Manned space exploration brings to the fore new problems which are essentially different and of another order of magnitude than those of conventional high altitude and high speed flight. The effects of ionizing radiation, weightlessness, and long-duration existence in an isolated, confining, artificial environment will require further mobilization of the talents of those who can contribute in the medical schools, industry, and other Government agencies as well as in

the military services. To the greatest practicable extent, it is the intention of NASA to utilize the personnel and facilities of groups qualified by training and experience to contribute in these areas of research.

Basic biologic studies of the effects of space and other planetary environments on plant and animal life as well as the search for extraterrestrial living organisms are very promising sources of important scientific information. These studies represent a penetration into fields of research in addition to those which have been or would be explored in depth by the military services in satisfaction of a military requirement. Here again, however, contributions will be sought from qualified groups of professional men wherever they may be found.

In order to attract and productively utilize the talents of individuals with outstanding scientific potential who will form a small but high quality nucleus of capability for leadership and integration of a national program, it is essential that an in-house facility be developed. Although it is anticipated that the major portion of the NASA life-sciences program will be conducted through grants and contracts with universities, industry, and the military services, individuals of sufficient stature and a full-time interest will be indispensable in establishing and maintaining an appropriate degree of active participation with the physical scientists and engineers in the other operating divisions of NASA. A new facility in which this personnel complement will productively pursue their relevant interest will concentrate on the programing and development of biological experiments in space, medical, and behavioral sciences, and basic biological research. This emphasis will assure no conflict of interest with the existing aerospace medical laboratory's outstanding competence in biotechnology.

The NASA Office of Life Sciences has already established liaison with the military efforts in this field through the Office of Defense Research and Engineering in the Department of Defense. Tri-service representation in bioastronautics has been brought together in this Office under the Director of Science for joint consideration of future plans and transfer of funds, when necessary, to directly support appropriate proposals from the Army, Navy, and Air Force.

The NASA Office of Life Sciences has been established to provide a focal point for activities in this area on a national and international scale. It is the well-defined purpose of the Office to augment desired current programs and to supply the impetus for further life sciences contributions in space exploration.

2. What specifically are NASA's future plans for its new Office of Life Sciences in terms of staff size, budget amounts, and programs to be undertaken directly or sponsored?

In fiscal year 1961, the Office of Life Science programs anticipates a total personnel complement of 32, of whom 18 will be professional staff members. It is planned to conduct the program at a $5 million level.

The Office of Life Science programs will be concerned with studies and detailed planning of the biomedical aspects of future manned space flight missions. A program of biological experiments in the upper atmosphere and space will be started. Funding of $3 million is anticipated for these efforts. A grant and contract program in support of these projects will be administered with the $2 million allocated for NASA sponsorship of bioscience research, as shown on page 146 of the authorization justification book. A life sciences research center for flight medicine and biology, space medical and behavioral sciences, and space biology will be planned. It is not anticipated that this proposed facility will duplicate the biotechnological capability now present in the military service laboratories.

3. On page 144 of the NASA authorization request justification book it is noted that the amount being requested for "research grants and contracts" in fiscal year 1961 is $10 million.

How much of this amount will be devoted to research grants and contracts in bioscience, which is one of the categories that will be included in the program, as is indicated on page 145 of the book?

Of the $10 million requested for NASA research grants and contracts, $2 million will be allocated for NASA sponsorship of bioscience research, as shown on page 146, and explained under question 2.

4. In testimony before the House Committee on Science and Astronautics on March 9, 1960, Dr. Dryden said with reference to NASA use of military biomedical facilities: "* * * we are going to continue to use the service

laboratories. The estimate is that three-quarters of our effort in this field will always be in the universities and service laboratories."

Would you please indicate to the committee how much, if any, of such funds in NASA's authoriation request for fiscal year 1961 will be transferred to the Department of Defense for NASA work performed in service biomedical laboratories on a reimbursable basis?

The amount to be transferred to the Department of Defense for NASA work performed in service biomedical laboratories is anticipated to be a significant fraction of the total funding of the Office of Life Science programs. A specific amount will require more detailed consideration of NASA requirements in this area and further review of personnel, facilities, and programs now present in the service installations.

5. On page 5 of the report of the NASA Bioscience Advisory Committee, the so-called "Kety Report" which served as the basis for NASA establishing an Office of Life Sciences, the following statement is made: "Supporting medical research and development in applied medicine and biology is being carried out in existing military aviation medicine facilities. Among 40 service biomedical laboratories 15 have noteworthy bioastronautics capabilities. The cost of these facilities is roughly estimated to be about $80 million. The 1960 Department of Defense budget for life sciences research and development is $47 million, including approximately $10 million for bioastronautics."

Does NASA plan to neglect or make use of these existing military facilities in its future long-range life sciences programs? How will this be done?

The NASA intends to make use of the existing military facilities in its future long-range life-sciences programs by direct transfer of funds in support of appropriate projects. The means for coordinating such activity was initiated at a meeting in the Office of the Director of Defense Research and Engineering of the Department of Defense on March 1, 1960. Mr. Richard E. Horner, Associate Administrator of NASA, and Dr. Clark T. Randt, Director of the NASA Office of Life Sciences, met with Dr. Orr E. Reynolds, Director of Science, Col. John M. Talbot, Chairman of the Technical Advisory Group for Bioastronautics, and members from the Army, Navy, and Air Force, representing the Department of Defense.

6. NASA has frequently acknowledged publicly the valuable assistance the military biomedical facilities and personnel are giving in support of Project Mercury.

(*a*) What proportion of Project Mercury's biomedical requirements are being supplied by the Defense Department?

(*b*) Would the undertaking of Project Mercury have been possible without biomedical support by the military?

(*c*) Has the Defense Department been reimbursed for the substantial facilities and personnel it has committed to Project Mercury, except for travel expenses and other minor costs. What major reimbursements have been made?

(*a*) Almost all of the biomedical requirements of Project Mercury have been supplied by the Department of Defense. This assistance has been in the form of direct assignment of military personnel to NASA's Space Task Group and in making available facilities and other personnel for consultation and support. Typical facilities include the Navy centrifuge at Johnsville, Pa.; and the Air Force facilities for nutrition, biophysics, and physiology at the Wright Air Development Division; the high-speed track and vivarium at the Aeromedical Field Laboratory at Holloman Air Force Base; and the facilities at the Aerospace Medical Laboratory at Brooks Air Force Base.

In addition to the DOD-furnished equipment, other Mercury biomedical requirements are being supplied by NASA and its contractors. Specific examples include all the biomedical equipment within the Mercury capsule and at Mercury ground network stations.

(*b*) The undertaking of Project Mercury would have been substantially more costly and its operation may possibly have been delayed without biomedical support by the military services.

(*c*) The Department of Defense has been reimbursed for special equipment at the various military biomedical laboratories, for travel expenses, and for the salaries of medical personnel detailed to work directly within the NASA

organization. Major reimbursements to the military include $25,000 to the Navy for pressure suits and $75,000 to the Air Force for support of the Mercury animal training program.

7. If in the future the military biomedical programs commit substantial proportions of personnel and facilities to NASA without adequate reimbursement for such assistance, do you feel that the Defense Department should be able to justify the existence of its biomedical facilities in part on such work that it performs for NASA?

It is the intent of NASA and the Department of Defense to coordinate the support of much of the work that will be mutually useful; however, NASA will reimburse the Department of Defense for those programs carried out in the military biomedical laboratories which are specifically for NASA programs. Therefore, the need to justify the existence of military biomedical facilities on the basis of work performed for NASA should not arise.

8. In fiscal year 1959, the National Science Foundation's annual obligation in support of basic research in the biological and medical sciences was about $20 million, and about $3 million for research facilities in the biological and medical sciences. Additional millions were spent through grant and fellowship programs. Other Government agencies spend substantial amounts every year in this very worthwhile area.

One of the recommendations of the "Kety Report," the report of NASA's Bioscience Advisory Committee, was the following:

"That the Office of Life Sciences assume proper responsibility for education and training in the space-oriented life sciences through postgraduate fellowships, training grants to institutions, and short-term visiting scientist appointments to be integrated with other NASA efforts in this area."

In view of the extensive programs already being carried out by Government agencies in this area, what specific plans does NASA have for the establishment of sound mechanisms for coordination with other Government agencies having related programs of support involving grants, fellowships, and basic research, so that research results can be made known and utilized to the maximum extent possible?

Planning for coordination of life-science research and training programs is recognized as being highly desirable. As a first step, the NASA Office of Life Sciences will participate in the bioscience information exchange which now provides service to the Army, Navy, and Air Force, the U.S. Atomic Energy Commission, the Veterans' Administration, the U.S. Public Health Service, and the National Science Foundation.

NASA recognizes a unique role in providing educational opportunities for life scientists as well as physical scientists in space exploration as well as the need to stimulate interest and accomplishment in studies of this newly opened environment by scientists now concerned in related fields of endeavor.

9. What coordinating groups now exist and what groups are planned for the future to insure that NASA coordinates the operations of its Office of Life Sciences with related programs in governmental and nongovernmental organizations?

Except for the previously mentioned coordinating Technical Advisory Group for Bioastronautics in the Department of Defense, other liaison groups are now in the planning stage.

DR. GLENNAN ADMITS HE HAS NO EVIDENCE TO SUPPORT HIS STATEMENT

Senator YOUNG. Dr. Glennan, Senator Smith asked you for some clarification of your statement on page 11 and so perhaps, based on my own experience as a trial lawyer, I will follow up with a question based on page 11 of your statement.

You said that by 1964, the Saturn will be operational, and then you said that you doubted that the Soviet Union will exceed us in thrust capability after that time—that is, after 1964.

Now, what is your evidence for this statement?

Dr. GLENNAN. I was afraid you might ask me that. And I have none. Perhaps it is gratuitous to put the statement in there. But so

many people have made life difficult for us, because we were unwilling to say we are going to do this or going to do that, that I think I am entitled to a reasonable guess that the activities we have underway at the present time are not going to be exceeded by the Soviet Union.

Senator YOUNG. Well, I don't want to harass you on that subject, but may I ask what reason have you to believe that the Soviets are not developing large superboosters at this time?

Dr. GLENNAN. I would expect they are. But I doubt that they will be any larger than the ones we are developing, Senator Young. There gets to be a limit to this sort of thing. We have the Saturn laid on as a base rocket of a million-and-a-half pounds thrust. We have upper stages, as you know, that will be in the liquid oxygen-liquid hydrogen class, which give us a very high specific impulse. This should result in the development of a really powerful system. It ought to put up as much weight as anybody really would want to put up. And I doubt that the Soviets will exceed that.

Senator YOUNG. Well, if there is a limit, then, why are we developing Nova?

Dr. GLENNAN. I didn't say there was a limit. Or at least I didn't mean to say there was a limit. I simply mean that I don't think they will go beyond the concepts that we have laid on, which really go very, very large indeed for these types of rocket systems. You and I, Senator Young, are not going to want to be very close to the Saturn when it lifts off at Canaveral.

SOVIETS WILL NOT WAIT FOR UNITED STATES TO CATCH UP

Senator YOUNG. Well, Dr. Glennan, after the tremendous propaganda gains the Soviets have made with their space achievements, do you think that they are just going to sit around, and wait for us to catch up with them?

Dr. GLENNAN. Not at all. I don't think so at all. But I think that I am entitled again to voice an opinion that the scoring system is going to change one of these days. Thus far it has been a matter of weight-lifting. We are, I think, particularly now with Pioneer V, out there a good many hundreds of thousands of miles, not to say millions. I think we are really experiencing a change in attitude abroad, already. I believe that there will come a time when the ability to put weight up is not really going to be what counts.

As I read my statement to you, and remarked about the difficulties we have had in miniaturization and in devising all kinds of gimmicks for weight-saving purposes, that I might well have gone on to say that these troubles we have had to overcome ought to add tremendously to our capabilities as we get even larger rocket systems.

It does seem clear, and I think that maybe it is time the American people really were told this by me, by you, and by others who could understand these things, that the United States had made tremendous progress in this field in a very short time, starting with zero velocity. And the kind of sophistication that is built into Pioneer V, in that total system, was designed, built and launched in the short space of about 14 months—14 months.

I think it is really an achievement. And we ought to be proud of it.

Senator YOUNG. Well——

Dr. GLENNAN. This doesn't say that the Soviet Union is not going to be progressing. I think they are. I just think that the kind of approach that we have taken, as compared to the kind of approach they thus far have taken, leaves no other answer than that we will really achieve superiority in this field.

SOVIET SPACE SUCCESSES HAVE HAD GREAT IMPACT ABROAD AND INCREASED CREDIBILITY OF OTHER SOVIET CLAIMS

Senator YOUNG. But just recently George V. Allen, Director of the USIA, stated:

Today, although we continue to see the hope expressed abroad that the United States will catch up, we also see growing doubt that this is likely during the next 5 or even 10 years.

What can be done to erase that doubt that he speaks of?

Dr. GLENNAN. I could be facetious, and say, "Just provide us with this money, and we will get on with the job." But I really think——

Senator YOUNG. We did that last year; you asked us and we provided, and we will probably do it again.

Dr. GLENNAN. And we have delivered for you. I think, sir, that Mr. Allen is perfectly right in his evaluation of the impact of the Soviet successes abroad. Your question, as I recall it, is what are we doing about removing that impact?

I suspect we will never wholly remove it. One cannot turn back the clock. But I think that the kind of a program that we have outlined for you, the target dates we have set up there, the progress we have made—and it has been solid progress—means that in as reasonably a short a time as possible, we are correcting that imbalance. No one can be definitive about this. I am confident because I have more confidence in the organization we have, and in the planning that we have been able to do in this last year.

Senator YOUNG. Well, now, I am reading another statement of Director George Allen, and my question, Dr. Glennan, is whether you agree with it or not.

One interesting and perhaps dangerous aspect of Soviet success in space has been the new credibility it has lent to Soviet claims in these other fields. Before sputnik, most Soviet pronouncements of spectacular achievements were usually dismissed as propaganda. Since sputnik, their claims have been much more often believed.

Dr. GLENNAN. I would think that this could well be the case.

Senator YOUNG. You agree with that statement?

Dr. GLENNAN. I would think it could well be the case.

Senator YOUNG. And what are you doing about that?

DR. GLENNAN FEELS WE WILL WIN THIS "TUG OF WAR" WHICH IS TOUGH COMPETITION BUT NOT A RACE

Dr. GLENNAN. We are working just as hard as we can on this program, sir. I think we ultimately will win this "tug of war."

Senator YOUNG. Well, do I understand that it is your belief that we are in a space race with the Soviet Union?

Dr. GLENNAN. No, sir. Let me explain that categorical denial. We are in a really tough competition. A race is a different thing,

Senator Young. In a race, there are a couple of competitors. They each start from the same baseline. They each move along the same track, over the same hurdles. And there is an end in sight. One of them reaches it first or the other reaches it first. That is a race. I don't think we can call the competition in which we are engaged a race in the sense I have spoken. We don't know what track they are running on. We don't know what their next objective is going to be.

Senator Young. Do we know what our next objective is?

Dr. Glennan. Yes, sir; you see them right up there on the chart. I think that we are really in a tough competition. It is one part of a total competition between this Nation and the Communist ideology. It happens to be a very visible one. It happens to be a very glamorous one. It happens to be the one in which they can speak with the most propaganda value at the present time. Therefore, it is tough. And we ought to be doing something about it. And I think we are.

Senator Young. Well, it is a tough, tremendous competition that we are in with the Soviet Union, whether you call it a race or not.

Dr. Glennan. I couldn't agree with you more, sir.

SOVIETS HAVE CAPABILITY TO DEVELOP LARGE SUPERBOOSTER

Senator Young. You do feel that the Russians do have the scientific, technical, and industrial capabilities, to develop a large superbooster, do you not?

Dr. Glennan. Yes, sir.

Senator Young. My time is about up, I have just a few more questions.

Further regarding the Soviet capability, in late January they announced that they had successfully tested "the more powerful rockets" that they are perfecting, "in order to launch heavy satellites and undertake space flights to planets of the solar system."

Now, any comment to make on that, Dr. Glennan?

Dr. Glennan. No. I am not surprised by such an announcement. It would be the sort of thing that we would be doing, and indeed are doing. And it seems to me a normal progression in their program.

Senator Young. I am a little uncertain myself, and I wonder, what is your judgment as to what the Soviet propagandists mean when they refer to more powerful rockets?

Dr. Glennan. There are two ways that this might come about. I think many of us have been—I don't want to say "concerned," but have wondered, whether indeed they had some of the same problems we have in making—in exploiting completely the power we think they have in that first-stage rocket—whether their second stage and upper stages are as adequately proportioned to the power in the first stages as they might be.

If not, then they would be doing the same sort of thing we are doing with the Atlas, the Agena B, and the Atlas-Centaur—developing second stages to make full use of the thrust available in the lower stages.

I would think, also, that they very probably are building larger rocket engines. I have no reason to know this. But I certainly have no reason to doubt it.

RECENT SOVIET PACIFIC TESTS WERE PROBABLY SUCCESSFUL

Senator YOUNG. Having in mind that they are encountering the same problems as we are, in your opinion, were the Pacific tests by the Soviets successful?

Dr. GLENNAN. Well, not knowing what their objectives really were, I don't know whether they were successful or not. They said they were. And certainly the tests went down range about the distance that they announced.

Senator YOUNG. Well, judging from our standards, and based on your information, you consider that they were probably successful, do you not?

Dr. GLENNAN. I would think they were probably successful.

Senator YOUNG. May I just ask another question. What would be the definition of a "heavy satellite"?

Dr. GLENNAN. The heaviest one they have put up thus far is a little over 3,000 pounds. This is heavy to us at the moment. We expect, however, to be putting up satellites of that weight rather routinely by 1962 and beyond, and substantially heavier than that. I would guess when you get up to satellites in the neighborhood of 15 tons, 30,000 pounds, where the satellite itself, the spacecraft itself would probably cost you $50 million, this is really a substantial piece of satellite.

Senator YOUNG. Well, what is your expectation that the Soviets will be putting up in 1962, if you have any expectation on that?

Dr. GLENNAN. I don't know. I think I will wait and see, sir.

Senator YOUNG. Would you think that they will have heavier than ours at that time?

Dr. GLENNAN. I would think only if they needed to.

DR. GLENNAN DOESN'T THINK THE SOVIETS ARE BLUFFING

Senator YOUNG. One final question, Dr. Glennan. Do you believe that the Soviet leaders are bluffing when they say that they are developing more powerful rockets—I am quoting this propaganda—heavier satellites and space flights to the planets?

Dr. GLENNAN. No; I don't think they are bluffing.

Senator YOUNG. Senator Martin?

DR. GLENNAN DOUBTS NASA WILL REQUEST ADDITIONAL APPROPRIATIONS FOR FISCAL YEAR 1961 BEFORE CONGRESS ADJOURNS

Senator MARTIN. Dr. Glennan, will we be supplied copies of these charts?

Dr. GLENNAN. Yes, sir.

Senator MARTIN. They are not in our materials here.

Dr. GLENNAN. I am sorry. They should be—and we will see that you have them.

Senator MARTIN. The House bill, H.R. 10809, passed by the House March 9, authorized the full amount of $915 million—$802 million as requested in the original budget, plus the $113 million requested in the budget amendment of February 8, I understand.

Dr. GLENNAN. That is right, sir.

Senator MARTIN. That is all you are asking us for now?

Dr. GLENNAN. That is right.

Senator MARTIN. You have no further——

Dr. GLENNAN. We have no other amendments. I make again to you the statement that I made last year, that if we find the need for additional funds, we will, through the proper channels, be coming right back after them.

Senator MARTIN. It might be possible that you may find that out before adjournment?

Dr. GLENNAN. Assuming your adjournment is going to be early in July at the latest, this being April 1, I doubt that we would. Unless we ran into either an unusually difficult task, or an unusual opportunity to exploit, I doubt that we would be coming back at that time for a supplemental, sir.

Senator MARTIN. I notice here, in your appropriations summary, there is $170 million plus for salaries and expenses, $122 million plus for construction and equipment, and then $621 million plus for research and development.

You can gage your salaries and expenses and construction and equipment fairly well at this time for the next 3 months?

Dr. GLENNAN. Yes, sir.

Senator MARTIN. Any adjustment that may be needed would probably come in the research and development field.

Dr. GLENNAN. I think that is the case; yes, sir.

SMALLER WARHEADS LEAD TO SMALLER OVERALL SYSTEMS

Senator MARTIN. I am very much interested in your statement on page 3 that our decision to develop a rocket propelled ballistic missiles system was made after nuclear warhead development had proceeded to the point where we could plan on smaller overall systems to deliver the same punch.

We could face quite a different situation if there should come some international agreement on the matter of nuclear warheads. Wouldn't that change this picture?

Dr. GLENNAN. No; I think not, Senator Martin. One would expect that the decisions which have been made, carried out by this Nation, to build the kinds of rockets for the propelling of nuclear warheads to targets, envisaged the destruction, complete destruction, of those targets, with that size warhead. And those, I would presume, are in our inventory.

Seantor MARTIN. You have already planned your schedule, as I got from your statement, to overtake Russia in the heavy weight-lifting.

Dr. GLENNAN. I think that we are really moving ahead very rapidly on that.

Senator MARTIN. Any agreement to reduce or take out nuclear developments would force us in the direction of heavier weight-lifting, would it not?

Dr. GLENNAN. In order to carry a heavier weight of conventional explosives? My guess is that you would not propel conventional explosives to a target with an intercontinental ballistic missile. But I really, Senator Martin, am not capable of discussing this with any certainty.

Senator MARTIN. Of course, I realize that your role is not that of military planning.

PRESENT DISCUSSIONS ON NUCLEAR TEST CESSATION DO NOT CHANGE RELATIVE STRENGTH IN WEAPONS

Dr. GLENNAN. That is right. I would think, however, that the present discussions of test cessation really change very little the relative situation as between ourselves and the Russians in the weapons field.

Senator MARTIN. The program you have outlined to us here now is such that you would be prepared to meet any eventuality in international agreements?

Dr. GLENNAN. I am sure of that.

Senator MARTIN. That is all I have.

Senator YOUNG. Senator Cannon?

DR. GLENNAN FEELS THAT THERE IS NO QUESTION BUT THAT WE WILL EVENTUALLY CATCH THE RUSSIANS

Senator CANNON. Thank you, Mr. Chairman.

Dr. Glennan, I was rather interested in your comment that we were not in a space race with the Russians, when you made that categoric statement, because the comparisons that you have made here today, in comparing our capabilities with that of the Russians, made it appear to me that actually we were in a space race. I noted your comments that you don't know what track they are on, and you don't know what their objectives are. But if we assume that they are on the same track we are on, and if we assume that their objectives are the same as ours, then would it be fair to say that they are ahead of us in that race, if it be a race?

Dr. GLENNAN. This, I guess, gets into the good old question of semantics.

I must, I think, Senator Cannon, say that they would have a leg up on us in the matter of thrust. We, I think, certainly have a leg up on them in the matter of the sophistication of our scientific results—both as to equipment and the use that we are making of it—the interpretation we are making of the information that is coming back. If the course is sufficiently long, our leg up is going to be better than theirs.

Senator CANNON. In other words, we may be able to catch them eventually?

Dr. GLENNAN. I don't think there is any question about that, Senator Cannon.

Senator CANNON. Because I note that you think we will achieve superiority in the field of boosters, for example, and you also said that we will correct the imbalance that now exists, which would lead me to believe that there is an imbalance certainly.

Dr. GLENNAN. I think there is the imbalance in these spectacular thing they can do, and these, I think, are important, particularly in the international field, Senator Cannon.

Senator CANNON. And would it be fair to say, then, that there are many areas in the space field in which they are ahead of us, and that we are striving desperately to get ahead of them at this time?

Dr. GLENNAN. No, sir. I would disagree with this. I think there is one area in the space field in which they are ahead of us, and that is in the amount of thrust they have in their rockets. We are striving

very diligently to build the kind of launch vehicle systems that will give us that same or even greater capability.

In the meantime, we are, I think, surpassing them, sir, in the use that we are making of the capabilities that are already available to us. We are getting more good, useful solid information than are the Russians.

UNITED STATES AND SOVIETS ABOUT EQUAL IN GUIDANCE

Senator CANNON. Well, what about that lunar impact? Now, I note that your schedule calls for it in 1961. Apparently the Russians were able to accomplish it in 1959. Any indication that perhaps they have better guidance?

Dr. GLENNAN. Senator Cannon, it was simply, I believe—and we are conjecturing, of course—that they had the weight lifting capability to carry the guidance with them, as well as the instruments which telemetered back certain information about their approach to the Moon.

In our instance, we do not have enough thrust to both carry a sizable payload and to carry the sophisticated guidance needed for that kind of a shot.

Senator CANNON. Would you say that our guidance is any better than theirs, Dr. Glennan?

Dr. GLENNAN. I don't know that it is any better, and I don't think it is any less good.

Senator CANNON. But we have not proven that ours is any better when we take into consideration the Lunik shot, the Moon shot, when we took into consideration the Pacific missile shot? We haven't had any better results, guidancewise, than those, have we?

Dr. GLENNAN. With respect to the Pacific missile shots, I think we have done just as well as those in our missile business. I think the accuracies achieved have been just as good as those. Now, we have to separate satellites and missiles here, space and missiles. Because I think in the missiles there is a real standoff in the business of capability. I don't know about numbers or anything like that. It is not my business. But in the space business, it is my conviction that given the thrust capability, our guidance will be adequate to any task that we put on it.

Senator CANNON. Well, now, in answer to a question from Senator Young, you indicated that we would be able to lift as heavy a satellite as they by 1962, and that they would probably not develop any greater booster capability, unless they needed to.

Dr. GLENNAN. Yes, sir.

SOVIETS CAN DEVELOP GREATER THRUST IF THEY NEED IT

Senator CANNON. I am wondering if by that statement you are conceding that they are or would be capable, in your opinion, of developing a greater thrust than we will have at that time.

Dr. GLENNAN. I know of no reason why they should not be capable of developing greater thrust. My comment there was directed toward what I firmly believe, that there comes a time when they run out of these spectacular firsts, so-called, and maybe then they won't be worrying about 3,000-pound payloads, when they see what can be

done with a 94-pound payload. So I just don't know what their requirements will be.

We happen to have laid on requirements looking 10 years and more ahead, which are going to require the kind of thrust that we are looking for in the Saturn and in the Nova concept.

Senator CANNON. But if they felt they needed to, then, with the start that they have on us in this greater thrust area, you think that they probably would be able to develop a greater thrust at that time, if they felt they needed it.

Dr. GLENNAN. If they started enough years back, Senator Cannon, yes. I don't think they could do this in a couple of years.

Senator CANNON. They obviously started further back than we did.

Dr. GLENNAN. I assume you mean in terms of developing the larger engine.

NASA PUSHING NUCLEAR ROCKET PROGRAM

Senator CANNON. I see, Doctor, on page 8 of your statement you said,

> It should be noted that together with the Atomic Energy Commission, we will be developing nuclear rocket systems which promise substantial advantages for particular missions involving heavy payloads.

Now, in outlining the launching vehicles that you covered in your 10-year plan, no mention was made of nuclear rockets. I wonder, do you consider nuclear rockets important, or capable of being developed for space missions within the next 10 years.

Dr. GLENNAN. I certainly do. And I think that this is probably just a bit of bad judgment in not putting into that chart a notation on the nuclear rocket.

We believe that the nuclear rocket system, Rover, ought to be developed as fast as the technology will permit. We have so stated to the Bureau of the Budget in a letter. I think it had something to do with the improvement in the funding that has recently been accorded the Rover program.

I think, Senator Cannon, that a much more comprehensive and understandable statement of the utility of the nuclear rocket will be given to you by one of my colleagues when you define this program in a little bit more detail. But I would leave with you a strong impression that we are interested, we are pushing this program. We are presently discussing management techniques with the AEC, in order that there be eliminated any possibility of this project being attacked, as it has been, as something that is falling between the cracks. This, sir, is not the case.

RELATIONSHIPS BETWEEN AEC AND NASA

Senator CANNON. Now, this project is handled jointly by NASA and the AEC. What is the exact responsibility of each of those two agencies, and how are those responsibilities coordinated between the agencies?

Dr. GLENNON. The Atomic Energy Commission has the responsibility for the development of the reactor. NASA has the responsibility for the development of the non-nuclear parts of a rocket system, which would include the pumps, the expansion nozzle, tankage, the vehicle, flight testing, and all the rest of that.

For the next couple of years, the Atomic Energy Commission will be spending the larger proportion of the money involved in the total project. Beyond that, NASA will be spending a very much larger amount of money than the AEC.

At the present time we are in discussions with the Atomic Energy Commission in an attempt to develop a management mechanism which will combine the resources, rather than coordinating them, if you will.

Presently there is a Rover coordinating board, through which discussions have been had and reported to the Atomic Energy Commission and to the Administrator, with respect to rate and scale—that is the size of the program and the pace at which we want to push it.

The questions raised by Senator Anderson, among others, have given us reason to look at this management mechanism and question whether it is as directly effective as it ought to be. I have no question but what we will resolve this satisfactorily.

Senator CANNON. I note that you mentioned Senator Anderson and he recently wrote you that he felt responsible for the development of the nuclear rocket through the flight test phases with an integrated prototype propulsion system should be assigned to the AEC with the understanding that NASA would provide the Commission with consultation and assistance. What are your comments on that, Doctor?

Dr. GLENNAN. I believe I have answered that letter, Senator Cannon, outlining essentially what I have just told you.

The Atomic Energy Commission does not possess the skills necessary to design and develop a rocket. We don't possess the skills necessary to the design and development of a reactor. I suppose we have a little bit more of that than they have of the rocket design skill, because we do have nuclear activities at the Lewis Laboratory.

Here is a place where the two agencies must be welded together, and the mechanism for doing that is under effective study at the present time.

Senator CANNON. You mention that that could be coordinated without losing the economy of one organization handling the entire program.

Dr. GLENNAN. I think not only is that the case, but to do it any other way would cost time and money.

B–58 WILL BE USED BY NASA TO TEST FEASIBILITY OF A SUPERSONIC COMMERCIAL TRANSPORT

Senator CANNON. Now, Doctor, I noticed a recent article in the Wall Street Journal that was entitled "Soviet effort to build supersonic transport spurs trial of B–58 as passenger aircraft." And a part of that I will take the liberty of reading:

> The Government officials, armed with intelligence that Russia is building a supersonic commercial transport plane, are preparing to take a new step towards developing a similar U.S. aircraft. The National Aeronautics and Space Administration is planning extensive flight tests of the B–58 Hustler Bomber to study how the 1,300 mile an hour plane would perform as a supersonic transport. The Delta wing jet produced by Convair Division of General Dynamics Corp. is currently entering combat use by the Air Force. Government concern that the United States is not making significant efforts to develop supersonic commercial jets is spurring the B–58 tests. Some top officials note Soviet progress in this area, and fear this country will face future competition from Russian planes.

What is the situation as far as NASA is concerned in the possible development of a supersonic transport, or in the conversion of the B–58 aircraft?

Dr. GLENNAN. Senator Cannon, if I may, let me just comment very briefly, and then perhaps Mr. Horner can carry on with further discussion of the technical matters involved.

We are interested, and have been for some time, in carrying out the kind of basic research necessary to provide the designers with information that they will need, should we ever, as a Nation, build supersonic transports.

The information you have with respect to the B–58 is accurate only in part. We are involved in the B–58, have been involved in that concept for a number of years, as a matter of fact.

The tests which we expect to make with the B–58 relate to a study of possible operating problems which will arise with the advent of supersonic transports.

The B–58 itself, I think, is not convertible to a transport configuration at all. I would like, however, to ask Mr. Horner if he won't comment more fully on that, because he has been on both sides of the Potomac on the B–58 situation.

Mr. HORNER. I might amplify just a little bit on this question of the conversion of the B–58 to a supersonic transport.

The NACA laboratories, with facilities and personnel that are now in the NASA organization, were deeply involved in applied research relative to the B–58. The B–58 as an airplane is a concept of a supersonic bomber, utilizing external storage of the payload. The actual payload for the bomber is carried along underneath the airplane in a pod. This provides the airplane with a very slender fusilage, and a wing which is capable of attaining these supersonic speeds, with the thrusts that are provided by the turbo jet engines. Obviously, this configuration is not very easily adaptable, you might say not at all adaptable, to a supersonic transport in that sense.

But as Dr. Glennan mentioned, some of the most difficult problems in supersonic transport development are those that are related to the operational aspects of the transport—things such as the stage length, the terminal problems, the holding problems, how the airplane will fly into crowded terminal conditions under adverse weather circumstances. And it is these kinds of problems that we are attacking in our flight test of the B–58. We intend to take the airplane and fly it over typical commercial stage lengths into terminals which will give us experience in how a supersonic transport actually would be introduced into commercial airline usage. I think we will get a great deal of useful information out of the airplane in this respect. But without any intent of making a direct conversion of this particular configuration into a supersonic transport.

NASA CONTINUES ITS AERONAUTIC RESEARCH

Senator CANNON. Well, now, Doctor, a highly placed military research and development man, at a House Space Committee hearing recently, complained that NASA was not living up to its responsibilities in continuing research for advanced aircraft development. Would you care to comment on that?

Dr. GLENNAN. Senator Cannon, you are referring to Admiral Hayward's testimony. He, I think, is not wholly accurate in his statements. We do continue to conduct research and development in the aeronautical field. I believe that Mr. Abbott will testify that slightly more than 25 percent of our effort in the research centers, Ames, Lewis, and Langley, is in the aircraft field, and that we have been responsive to each request that has been made of us.

Senator CANNON. When you say each request that has been made of you——

Dr. GLENNAN. That is, that we have not turned down the Navy on any request that they have made for particular research activities. In the meantime we are carrying on our own self-generated research activities to the extent that the needs of the field seem to indicate.

Senator CANNON. I am glad you added that, because my next question was going to be, you certainly don't wait in NASA until you get a request for research on a particular problem, to develop the research and the importance in this particular field?

Dr. GLENNAN. That is quite right. I made that statement simply because it seems to me a little difficult for the good admiral to decide just how adequately we are carrying on research and development, without being very intimately concerned with the activities in our centers.

We would be just delighted to have him spend some weeks there, and find out the extent to which we are involved in it.

We recognize a real responsibility here.

As a matter of fact, I am reasonably certain that there is need for continuing evaluation of the adequacy of our work and the work of others in this field, because we don't possess the only facilities in the Nation.

I do think that NASA will continue, as NACA did in the past, to look farther down the road at the probable problems in the aeronautics field than any other organization.

Senator CANNON. And do you feel that this 25-percent effort that you are endeavoring toward the aircraft development is sufficient in light of your overall program?

Dr. GLENNAN. I think it is reasonably adequate. This 25 percent is, of course, 25 percent of a little larger activity each year anyway. It is difficult, Senator Cannon, to divide sharply the sort of research activities into those that are applicable to the space field, the missile field, or the aeronautics field.

Much of the work that we do has some interest in each of these fields—work on materials, for instance.

Now, I don't quite know how one would split this up, because it is a very broad field with us, one where we are trying to get lighter materials with greater strengths to withstand higher heating rates—just a whole host of problems across the board, which are of interest in each of these fields as the requirement comes about.

Dr. DRYDEN. I would like to add one statement, Senator Cannon.

We, of course, cannot ignore the fact that the emphasis in the defense policy of the Nation is changing from aircraft to missiles. There is no significantly new advanced aircraft development going on in the Department of Defense. There are some projects with which we are are actively connected. The B–70 is the most recent one on which we have spent a great deal of effort.

The Navy, for example, has canceled out practically all of its water-based aircraft development. Should we, then, continue to do research on water-based aircraft? We felt that we could not justify the assignment of resources to development in areas where there was to be no use. We have a great deal of effort in the VTOL and STOL fields, and in supersonic research which is applicable to transports, in hypersonic research in connection with Dyna Soar and advanced air vehicles. But our program has been reduced in magnitude, largely reflecting the shift that is being made in the Defense Department from aircraft to missiles.

MOST RESEARCH PROBLEMS INVOLVING B–70 HAVE BEEN SOLVED

Senator CANNON. When you say that there is no substantial new development going on, and refer to B–70, do you say that by reason of the fact that the B–70 is practically "washed out" now as a program?

Dr. DRYDEN. Well, this is certainly bound to affect thinking about aircraft beyond the B–70.

Senator CANNON. Would you infer from that that the problems in connection with the B–70 have been solved, those immediate problems, the heat problems and——

Dr. DRYDEN. Generally speaking, yes. We devoted a very great many man-hours to the problems of the B–70, and I think it will be a successful airplane.

Now, its use in strategic situations is the question at issue—not its value as a technical instrument.

Senator CANNON. I am sure that you recognize, both of you gentlemen here, and your assistants also, that if the Soviets beat us in the development of a supersonic transport, that that is certainly going to also have a great important effect insofar as our world position is concerned.

Dr. DRYDEN. It is a very disturbing thought. If the Soviet Union produced such an aircraft, which would be the equivalent of this supersonic bomber aircraft, you would see a tremendous rush in this country to regain the lost ground that we have given up by making that decision.

Senator STENNIS. All right. Have you anything further, Senator Cannon?

Senator CANNON. Not a further question, but I certainly agree that it is unfortunate that we are always trying to catch up with them instead of trying to go out ahead of them for a change. We should stop talking about not being in the race, and actually get in a race, and get out in front for a change.

Thank you.

DEVELOPMENT OF NASA'S 1961 BUDGET REQUEST

Senator STENNIS. Thank you, Senator.

Doctor, I have just a very few questions that I should like to ask with reference to your budget formula. You can be as brief as you reasonably can, and at the same time be specific.

I wanted to ask you to describe in detail the various steps involved in formulating the NASA budget and program for the fiscal year 1961. Since the responsibility for Saturn was transferred to NASA in the

midst of the budget formulation period, please cover all NASA programs excluding Saturn, and then tell us separately what happened to Saturn.

Dr. GLENNAN. I will do my best, Senator Stennis, and ask the privilege of extending my remarks.

Senator STENNIS. Of course.

Dr. GLENNAN. I could start out by saying that I hope there will come a day when I hope we can go through a budget cycle without the sort of interruptions we have had in the last couple of years.

We attempted early in the year 1959 to give our centers some guidance as to the kind of program we thought we could undertake in the year ahead. This was a program designed to carry out what we had been doing, and to lay on additional tasks that would be coming to fruition several years in advance.

By September 30 we had come to the point of turning into the Budget Bureau a request for $783,300,000. We had in preparation at the same time a supplemental fiscal year 1960 budget request of $34.7 million, that number being approximately the amount by which our budget was reduced the year before.

This brought us to about $818,000,000 as our going-in figure. That was supplemented by the need for $140 million, the amount approved within the Defense Department for the Saturn before that project was turned over to us.

Adding those three together, as I recall it, brings us to about $958 million as the original request which we made to the Budget Bureau.

On December 11, discussions were finalized which approved a budget request of $825 million. We elected at that point to ask for $23 million as a supplemental 1960, to accelerate Mercury and one or two other projects, and go to $802 million as our budget request for fiscal year 1961, including the $140 million for Saturn. We had in essence absorbed, in agreeing to that reduction in our budgetary request—we had in essence absorbed the Saturn amount of $140 million.

I should point out, too, that the manner in which the Huntsville operation, under Dr. von Braun, was managed by the Army, is quite different than ours.

For instance, we request the money to pay our people throughout the year while the van Braun group under the Army was paid from the projects that they were able to get into the operation. There was some support outside of the Development Operations Division at Huntsville of which we did not have full knowledge when we agreed to take over von Braun's operation.

This approximated another thirty to $35 million that we had to provide in support of the group at Huntsville.

In looking at the Saturn project, we decided that it made no sense just to transfer it. If we were going to transfer it, we better get on with the job. And we moved within a month to accept technical responsibility, although we do not have the Huntsville group transferred to us yet, as you know.

In mid-December, we had agreed on the configuration to be used in the upper stages. We were getting a little better picture of what we wanted to do with the Saturn, frankly. As we came to the end of the year, and the probability of sending up our budget request for $802 million, in discussions with the President, I pointed out the significant

improvement that we thought we could make in the time scale by the addition of some money to the Saturn project.

He was very sympathetic, and asked that we provide him with information which would allow him to make a decision on this. And the result of that was that on February 1, as I recall it, he asked for another $113 million, of which $90 million was to be assigned to the Saturn project, with the balance, assigned to the F–1 engine and the development of the 200 K engine. Thus, a total amount of $113 million was added to the big booster projects.

Senator STENNIS. Expressly for that purpose, is that right?

Dr. GLENNAN. That is right, sir.

So one would say, I think, that when we added up all of our requirements we had about $958 million in our original requests, and we wound up with $915 million as a budgetary figure.

Now, there may be some errors in that addition. Plus the $23 million supplemental. That would be 938, I guess—that is right. But I would much prefer to put this all in the record in a sensible way for you, if we may.

Senator STENNIS. Yes, if you will (see p. 57).

NASA REFUSED TO ACCEPT BUDGET CEILING FOR FISCAL YEAR 1961

Senator STENNIS. Dr. Glennan, did the Budget Bureau impose a ceiling on you to start with, when you were first making your budget plans? Didn't you have a ceiling on you to start with?

Dr. GLENNAN. No, we really didn't, sir. At least, we never accepted one.

Senator STENNIS. Well——

Dr. GLENNAN. Mr. Horner said I couldn't believe it. And I think this is about right.

Senator STENNIS. I didn't understand that.

Dr. GLENNAN. He said I couldn't believe the ceiling they wanted us to accept, so we didn't accept it.

Senator STENNIS. Yes. Well, you won't be disclosing any confidences to just tell us what it was.

Dr. GLENNAN. A figure slightly higher than the one we had last year, which would put it in the $550 million category.

(The following statement was subsequently provided to the committee:)

The National Aeronautics and Space Administration did not receive at any time a formal budget ceiling from the Bureau of the Budget. During the lengthy series of informal discussions of the NASA's budget estimates with personnel from the Bureau, various areas of possible adjustments were, from time to time, discussed which, if accepted, would have produced a NASA budget of approximately $550 million, exclusive of the Saturn responsibility. However, the NASA did not accept these unofficial suggestions and they were not reflected in the final official recommendations of the Bureau of the Budget to the President. The estimates currently before the Congress—$23 million (supplemental, fiscal year 1960) and $915 million (regular, fiscal year 1961) have been completely supported by the Bureau of the Budget.

Senator STENNIS. Yes. Well now, after you got your Saturn money, though, you were still short about $133 million, were you not, from what you had originally planned?

Dr. GLENNAN. Well, I will have to add this up. Yes, I think that is a reasonable statement based on our orginal requests. We modified

those requests however, at the time the addition for the Saturn project was discussed. I believe our final allowance was about $58 million below our modified requests.

Senator STENNIS. What item did that include?

Dr. GLENNAN. Again, I will have to supply that to you for the record. I think a substantial piece of it was in the construction and equipment area. Is that right, Mr. Horner? Perhaps you have a ready answer to that.

Mr. HORNER. Yes. Of course, this whole picture is somewhat confused by changes in program during the budgeting cycle. Actually, there was a major change in our program in the cancellation of Vega, which was a reducton in the program. Then, on the other major category of things was a reduction of facilities.

Senator STENNIS. All I am interested in—and I won't embarrass you gentlemen—I just want to know if you have had a chance to get in the items you think are essential. As one member of this subcommittee, I was really embarrassed when this matter came up about your lack of a booster project. And there has been a relatively small reduction in your appropriations for the current fiscal year. We feel like we have some responsibility in those fields, and are entitled to full information from you.

Now, we get a great many questions here about participation of other groups in the formulation of your budget.

The President has a special assistant for science and technology, who is also Chairman of the Federal Council for Science and Technology—Dr. Kistiakowsky. Now, did he participate in any way in the formulation and approval of your program?

NASA RECEIVED SUPPORT FROM PRESIDENT'S SCIENCE ADVISOR

Dr. GLENNAN. Dr. Kistiakowsky sat in on the discussions of the budgetary figures towards the end, but not in the formulation of it, no.

Senator STENNIS. He didn't help formulate and help you plan this?

Dr. GLENNAN. No, sir. This is our program.

Senator STENNIS. He came in at the end.

Well, now, did he approve or disapprove your figure, or have anything to do with what the final figure would be?

Dr. GLENNAN. He helped us support our figure, sir.

CHAIRMAN OF CMLC WAS NOT CONSULTED

Senator STENNIS. Now, what about Mr. Holaday. He is Chairman of CMLC. Did he participate in the formulation of your budget?

Dr. GLENNAN. He did not, sir.

Senator STENNIS. He had no part in it?

Dr. GLENNAN. No, sir.

ROLE OF THE SPACE COUNCIL IN BUDGET FORMULATION

Senator STENNIS. What part did the Space Council play in formulating the original budget, as well as the additional requests you submitted in February?

Dr. GLENNAN. They heard our presentations and generally approved them, Senator Stennis.

Senator STENNIS. What officials compose this Space Council?

Dr. GLENNAN. The Secretary of Defense, the Secretary of State, the Chairman of the Atomic Energy Commission, and myself, with the President as Chairman, are statutory members of the Committee. There is one additional official from the Federal Government in this instance, Dr. Waterman of the National Science Foundation, and three civilians.

Senator STENNIS. Well, now, did you really have active participation and assistance from these gentlemen in formulating this budget?

Dr. GLENNAN. I would not ask active participation from them in formulating the budget. They really wouldn't have the knowledge to help us very much on the detail necessary to the development of a budget.

Senator STENNIS. All right. What did they do?

Dr. GLENNAN. We presented the budget to them as a part of our long-range program. They saw the 10-year program, for instance. That was the first step in it. All of these matters were brought to their attention as one would expect to do.

Senator STENNIS. Now, was that before you yourself had reached any figures, or before it was ready to go to the Budget Bureau, or just when did they participate?

Mr. DRYDEN. They had a preliminary review of the long-range program, as I recall. And then after the submission to the Budget Bureau, and during the period when the augmentation of the super-booster program was under discussion and debated in the Space Council.

Senator STENNIS. They really didn't come into it so much, then, until the consideration of this additional program?

Dr. GLENNAN. That is right.

Senator STENNIS. Well, now, was their participation more or less advisory, or did they take part in decisions?

Dr. GLENNAN. They are advisory to the President, sir, and we only present materials to them on which he seeks their advice.

Senator STENNIS. I know those individual gentlemen with all of the other responsibilities that they have couldn't have much time to consider the budget in detail. But did their principal staff members work with you?

Dr. GLENNAN. I think, Senator Stennis, that it would be said that in the case of the Defense member of the Space Council, certainly we had discussions back and forth for weeks on it.

Senator STENNIS. Well, I just was going to ask. Just what was the coordination between NASA and the Department of Defense, in working out the 1961 budget as far as space is concerned?

Dr. GLENNAN. We had meetings with the Department of Defense on two or three occasions, in the course of working out our budget, and they presented their program to the Space Council at the same meeting we did ours.

Senator STENNIS. Now, as I understand, you are going to look over your answers here, and then you are going to detail step by step how you formulated this budget?

Dr. GLENNAN. That is correct. I want to be as responsive and accurate as I can be.

(The information is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CHRONOLOGY OF BUDGET PREPARATION—FISCAL YEAR 1961 ESTIMATES

March 30, 1959: Letter from Bureau of the Budget was received calling for preliminary review of budgetary situation and for informal discussions concerning agency's advance planning. This procedure was designed to serve in lieu of the submission of a preliminary budget and to expedite the preparation of the regular September estimate submission.

April 2–5, 1959: NASA management conference was held with key headquarters and field officials for discussion of policy issues involved in establishing the general framework of the 1961 budget and requesting tentative submissions by field centers. The conference included an exchange of views on (1) relative priorities between major program areas, (2) problems involved in incrementally funding major development contracts, (3) coordination of NASA efforts with the Department of Defense and other Federal agencies, (4) in-house operations versus contractual operations, (5) tentative staffing goals, (6) requirments for facility expansion, and many other policy considerations required to provide guidance to the field centers in the preparation of their preliminary estimates.

May 1–25, 1959: Administrator established Budget Policy Committee responsible for establishing general guidelines for preparing preliminary budget estimates, a budget analysis team, and a time schedule for estimate preparation. Headquarters program directors worked with field centers in preparing preliminary field submissions.

June 8, 1959: Preliminary estimates from field centers were analyzed and consolidated by headquarters program directors; preliminary agency budget at this point totaled approximately $835 million.

July 1–24, 1959: Budget analysis team studies were completed and discussed with the Administrator, Deputy Administrator, and Associate Administrator. These officials then met with the program directors for analysis, review, and revision of the preliminary estimates; agreement was reached on an agency budget totaling approximately $782 million.

July 31, 1959: Guidelines and limitations for formal estimate submission issued to field centers under allowances were approved by the Administrator.

August 4, 1959: Letter from Bureau of the Budget was received calling for formal estimate submission and stating that "both expenditures and new obligational authority are to be tightly restricted and held to minimum realistic working levels."

August 31, 1959: Formal estimate submissions were received from field centers.

September 21, 1959: Administrator gave final approval to items for inclusion in consolidated estimate submission.

September 30, 1959; Formal request for estimates of appropriations were submitted to Bureau of the Budget in the amount of $783,300,000.

October 20, 1959: Administrator was informed by the President that the Development Operations Division of the Army Ballistic Missile Agency, along with responsibility for the Saturn project, would be transferred to NASA. The Department of Defense estimate of $140 million for Saturn was to be included in the amount requested for NASA. On the basis of further budgetary review and the additional resources expected to become available to NASA with the transfer of the ABMA Development Operations Division, the Administrator suggested to the President the possibility of a $75 million reduction in the original NASA estimate of $783,300,000.

December 11, 1959: Bureau of the Budget approved a sum of $802 million for inclusion in the President's budget with the understanding that the sum included $175,873,000 ($140 million for the Saturn project) not included in the NASA original estimate submission to cover the pending transfer of the ABMA Development Operating Division to the NASA.

January 14, 1960: The President directed the Administrator to make a study, to be completed at the earliest date practicable, of the possible need for additional funds for the balance of fiscal year 1960 and for fiscal year 1961 to accelerate the superbooster program for which NASA had been given technical and management responsibility.

January 18, 1960: President's budget was transmitted to the Congress, requesting $802 million for NASA for fiscal year 1961.

January 26, 1960: NASA requested the Bureau of the Budget to approve amendments to the fiscal year 1961 budget in the amount of $125 million to speed work on the large-booster programs.

February 1, 1960: An amendment to the fiscal year 1961 in the amount of $113 million (including an additional $90 million for Saturn project) was approved by the Bureau of the Budget.

February 8, 1960: The formal amendment to the 1961 budget was submitted by the President to the Congress, increasing the NASA budget from $802 million to $915 million.

(NOTE.—The key milestones in the above chronology are summarized in the attached table:)

Formulation of budget for fiscal year 1961

	Requested by NASA	Approved by Bureau of the Budget	Bureau of the Budget reduction
Original NASA request to Bureau of the Budget	$783,300,000		
Addition for Saturn project	[1] 140,000,000		
Subtotal	923,300,000		
Reduction suggested by NASA Administrator	−75,000,000		
Net regular budget request	848,300,000	[2] $802,000,000	$46,300,000
Budget amendments to accelerate large-booster development programs	125,000,000	[3] 113,000,000	12,000,000
Amended budget request	973,300,000	915,000,000	58,300,000
Recapitulation:			
Gross total NASA budget requests	1,048,300,000		
Amount approved for transmission to Congress	915,000,000		
Total reduction	133,300,000		
Reduction suggested by NASA Administrator	(75,000,000)		
Reduction made by Bureau of the Budget	(58,300,000)		

[1] ARPA had requested Department of Defense approval of $250,000,000 for Saturn for fiscal year 1961. This had been reduced to $140,000,000 by the Department of Defense in its budget submission to the Bureau of the Budget prior to the decision to transfer responsibility for Saturn to NASA.

[2] Allowance includes $140,000,000 for Saturn project and $35,873,000 for supporting personnel and for other NASA operations at Huntsville. (Salaries and expenses—$20,797,000; Research and development—$7,076,000; Construction and equipment—$8,000,000.)

[3] Allowance includes $90,000,000 for Saturn project.

Formulation of budget for fiscal year 1961

	Salaries and expenses	Research and development	Construction and equipment	Total
	NASA estimates			
Original NASA request to Bureau of the Budget	$113,380,000	$569,181,000	$100,739,000	$783,300,000
Addition for Saturn project	34,316,000	92,684,000	13,000,000	140,000,000
Revision by NASA	(1)	(1)	(1)	−75,000,000
Amendment to accelerate large-booster development	7,000,000	90,000,000	28,000,000	125,000,000
Total	154,696,000	751,765,000	141,739,000	973,300,000
	Approved for transmission to Congress			
Original President's budget	$167,560,000	$545,153,000	$89,287,000	$802,000,000
Amendment to President's budget	3,200,000	76,300,000	33,500,000	113,000,000
Total	170,760,000	621,453,000	122,787,000	915,000,000

[1] Specific amounts not identified by appropriation pending study of additional resources expected to become available to NASA with the transfer of the ABMA Development Operations Division.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., March 30, 1959.

Hon. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

MY DEAR DR. GLENNAN: Each spring we must take a fresh review of the fiscal outlook and the general budgetary situation, as a basis for determining the policies to be followed in the preparation of the next budget. The development of these policies requires careful weighing of overall budget objectives against their possible effect upon the programs and responsibilities of each of the large agencies.

It is essential that we have an authoritative up-to-date view of the future plans of each of the large agencies. Accordingly I have asked Bureau of the Budget staff to talk informally during the period beginning about May 12 with the official on your staff to whom you look for the coordination of your budget development. In order that these discussions can achieve their purpose, it will be very important that you go over the outlook with him in advance of that date, giving him your views on (1) possible major changes in program levels in 1960 as compared with the January budget; (2) mandatory or "built-in" changes for 1961; (3) additional program changes for 1961 which are considered necessary from the standpoint of the administration's objectives; and (4) the outlook for your agency's programs for 1962 and 1963.

After our staff has such discussions in all of the largest agencies, we will pull together the budget outlook for the Government as a whole. I will then want to meet with you, probably about the 10th of June or shortly thereafter, for a personal discussion of your budget in relation to the total outlook.

We do not plan to go into details of budgetary requirements but rather to consider matters which would affect general budget policies and the effect of such policies on your agency. Therefore it is expected that the procedure outlined in this letter will serve in lieu of the submission of a preliminary budget. We believe that this simplification of the process will take less of your time and mine this spring, and will expedite and improve the preparation of your budget estimates for submission in September.

Sincerely yours,

MAURICE H. STANS, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., August 4, 1959.

Hon. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

MY DEAR DR. GLENNAN: You are aware of the fiscal objectives which the President has set for the fiscal year 1961. Both expenditures and new obligational authority are to be tightly restricted and held to minimum realistic working levels.

The budget submission covering the program of your agency and its financing is due in the Bureau of the Budget by September 30, in accordance with Bureau of the Budget Circular A–11. Please plan with your budget officer so that you can reach decisions in time for the complete submission of your agency to reach us on schedule.

The President desires that you devote your personal attention to preparing your budget along the lines discussed. He wants us to work together so as to facilitate his making of the final budget decisions later on, when time pressures become intensified.

Sincerely yours,

RALPH REID, *Acting Director.*

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THE WHITE HOUSE,
Washington, D.C., January 14, 1960.

Dr. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

DEAR DR. GLENNAN: As we have agreed, it is essential to press forward vigorously to increase our capability in high thrust space vehicles.

You are hereby directed to make a study, to be completed at the earliest date practicable, of the possible need for additional funds for the balance of fiscal year 1960 and for fiscal year 1961 to accelerate the superbooster program for which your agency recently was given technical and management responsibility.

Consistent with my decision to assign a high priority to the Saturn development, you are directed, as an immediate measure, to use such additional overtime as you may deem necessary on this project.

Sincerely,

DWIGHT D. EISENHOWER.

SEVERAL BACK-UP BOOSTERS PROVIDED FOR IN FISCAL 1961 PROGRAM

Senator STENNIS. Yes. All right.

Now, on these backup boosters, have you specifically included funds this time—for fiscal year 1961—for backup boosters, or launching vehicles? What are we to understand from you about that?

Dr. GLENNAN. We do not provide for a backup booster, if you will, or launching vehicle for each one of these shots. Our program is so designed that in the event we have a failure in a booster, we may be able to—we usually are able to bypass that experiment until we can pick it up at some later date.

If we were to provide backup boosters for every shot we make, it would double the cost of the program, and it would, I think, be about as ill-advised a use of funds as I could imagine.

We do have, in this program, if I recall correctly, some four launch vehicles that will be available for particular uses in the event of failure in any one of several programs.

In the case of the Atlas Able shot mentioned in your opening statement, Senator Stennis, had we had a second Atlas on the next pad, and tried to shoot it the next day, we would have made the same mistake all over again. Usually, these things fail for a reason. And one needs to study the evidence, and then try to correct it.

Now, it so happens that as a result of studies that have taken place since that unfortunate Thanksgiving morning shot—I was there watching it—we have laid on another shot of that type for later this year. We have actually set aside two Atlases, in this instance. One doesn't expect to have to use both of those, so we have put another payload aside for the second one.

Now, if the first one fails again, we will have an opportunity to use that second Atlas to carry the same payload for a third time. We just hope that is not to be the case.

LEADTIMES ARE GETTING LONGER

Senator STENNIS. You have to plan 12 or 18 months ahead anyway on items of that kind, do you not?

Dr. GLENNAN. Yes, sir; and more than that, sir, on some items. This program is getting more complex every day, and the leadtimes are getting longer.

For instance, I think it is reasonable to say that in our programs leading to the orbiting of astronomical telescopes, the leadtime is 3½ to 4 years.

ORIGINAL MERCURY COST ESTIMATES WERE MADE WITHOUT PREVIOUS EXPERIENCE

Senator STENNIS. Last year you made the following statement to this committee:

"The 1960 cost of Project Mercury is $70 million, and before we have completed this first U.S. effort to put man into space, the bill will have exceeded $200 million."

According to your budget justification book, the research and development costs of Project Mercury during fiscal year 1960 are now estimated at more than $87 million and the construction and equipment costs of the Mercury project net are estimated at $17,750,000. On this basis, the 1960 costs of Project Mercury are $105 million compared with the $70 million you estimated last year.

Similarly, Mr. Johnson, General Counsel of NASA, stated in a speech on December 10 that the total costs of the Mercury project over a 4-year period are likely to run around $350 million. This is almost double your estimate made at the beginning of the year.

Could you tell us in some detail what factors have been responsible for this significant increase in the estimated cost of the Mercury project?

Dr. GLENNAN. At the time of the $200 million estimate in February 1959, Project Mercury had been underway for only 5 months. A whole new area of technology was to be explored for the first time; there were no precedents or experience factors to go on in projecting the total program cost. Cost projections were made on what, at that time, seemed a realistic basis. Since that time, experience has dictated that the scope of the project be increased to insure accomplishment of the original program objectives in the safest possible manner. As a result of this increase in scope, the total number of Mercury capsules on order has been increased from 12 to 24; the number of Atlas boosters has been increased from 10 to 15; and the total number of flights with full-scale capsules has been increased from 27 to 33.

Contractor costs have been appreciably higher than contractor estimates. These costs increases of course show up directly in increased overall project cost.

Because of the urgency of Project Mercury, concurrent system development and production has been undertaken. When problems such as critical localized reentry heating have shown up during development tests, expensive changes have of necessity been made in the production capsule design. In addition to changes arising from the capsule development program, a considerable number of changes in capsule construction have been made to enhance system reliability and pilot safety.

At the time of the 1959 estimate, is was assumed that a considerable amount of effort now being contracted out would have been performed in-house by civil service personnel. In particular, the presently planned contractor flight preparation and network operations efforts had not been envisioned at that time. Personnel ceilings and increase

in the scope of the program have necessitated a large contractor effort in these areas.

A firm basis for estimating the network construction costs did not exist until the summer of 1959, when first contractor estimates were received on the cost of this effort. In February 1959, the magnitude of the worldwide network construction was not apparent. In the 5 months between October 1958 and February 1959, it had not been possible, with the personnel available, to attack both the flight system and network problems. The flight system was of course tackled first and it was not until later in 1959 that the network problem could be given adequate attention. The cost estimates for the network are now some 56 percent higher than originally.

COST ESTIMATE OF MERCURY IS NOW $344 MILLION, MAY RUN HIGHER

Senator STENNIS. What is your current estimate of the total cost of the Mercury project?

Dr. GLENNAN. $344,500,000.

Senator STENNIS. In view of the significant underestimation of the cost of Project Mercury last year, what assurance is there that the 1961 costs of the space program are not also underestimated?

Dr. GLENNAN. There can never be any assurance, in an R. & D. program, that the accomplishment targets will be reached within the fiscal year time span and dollar limitation estimated. However, 15 months of operation in a brand-new field have given us some experience and, therefore, some better ability to judge the cost elements and requirements involved in our program.

Senator STENNIS. Does the NASA budget for 1961 include any allowance for possible cost increases?

Dr. GLENNAN. Known overrun conditions and estimated contract costs are of course included, but no "surcharge" or percentage loading to establish a contingency fund has been included in our fiscal year 1961 estimates.

REIMBURSEMENT PROBLEMS HAVE BEEN SETTLED

Senator STENNIS. We have heard that NASA has had some problem in budgeting because it must now reimburse the Department of Defense for services or items which had previously been provided to NACA without reimbursement. Is this the case?

Dr. GLENNAN. The only real problem in this area arose when the Bureau of the Budget impounded funds designed to reimburse the Department of Defense for support of Project Mercury recovery operations. This question has been settled. The fact that items and services once "free" are now "paid" for has required simply that closer attention to all cost elements of a program be paid during the budget development process.

Senator STENNIS. I don't want to take too much time, but I do have two or three other questions concerning backup boosters. Mr. Lehrer, do you have something?

Mr. LEHRER. Senator, since Senator Smith has to leave for the floor shortly, I think it may be advisable for her to ask her questions now.

Senator STENNIS. All right. Let us yield to Mrs. Smith.

POLITICS PLAYS NO PART IN TIMING OF SPACE SHOTS

Senator SMITH. Thank you Mr. Chairman. Dr. Glennan, earlier in the afternoon, in answer to a question about the timing of the Mercury program, I gathered from what you said that the progress was such that the first ballistic missile flight would come toward the last of this year.

Dr. GLENNAN. Yes.

Senator SMITH. Now, the press has commented about rumors that the first ballistic Mercury flight would be timed just before election. It might be helpful in these hearings if you would comment on that.

Dr. GLENNAN. I would hope that I would be fired if I did that.

Senator STENNIS. Be what?

Dr. GLENNAN. Be fired, removed from office. I think that we do not take chances with men's lives in this country on that basis.

Senator SMITH. Thank you very much, Doctor.

Do domestic or international politics play any role in the timing of your space shots?

Dr. GLENNAN. I think it is accurate to say no. We have laid out a program which we believe to be a sensible program. We are pursuing it as diligently as we can. We have—Dr. Dryden and I—approved only one project that had as an element in its undertaking the acquisition of some particular international objective, and that was the first one that came to us after we had been on the job for about a week or two—these were the shots toward Venus last year. You will recall that having approved this, we were very watchful of the progress made, and it was necessary very shortly before the time when Venus was available to us to withdraw from that situation.

Indeed, Explorer VI, Pioneer V, and the Atlas–Able Moon orbiter were reprogramed, if you will, from the Venus project after the decision to withdraw was made.

Now, each one of these is a tremendously important shot.

I think I have gone beyond your question.

The answer really is that it does not enter into my mind maybe as much as some people think it should.

SENATOR SMITH FEELS WE SHOULD DO MORE TO PUBLICIZE OUR ACCOMPLISHMENTS

Senator SMITH. Dr. Glennan, you were speaking a few minutes ago also about the Pioneer V being a great accomplishment. It has seemed to me that it is one of our greatest accomplishments, and that few people realize how great it is.

Now, are we getting across to the American public, as much as we should, about great accomplishments such as Pioneer V? I think that because this is a very large appropriation, that as time goes on people will begin to question why so much money is necessary. And if Russia had done what you have done on a project like Pioneer V, I am sure that the publicity would have been around the world several times. I have not seen too much of that kind of publicity about our accomplishments.

Dr. GLENNAN. There has been a very great deal, and there has been a very great deal abroad, and the results abroad are very interesting, as a matter of fact.

I would like to have the privilege of bringing you a statement on this, which will be quotations from the newspaper services abroad. (See p. 560.)

In this country, I think we have done reasonably well. There was another show last evening on television, which I presume was seen over the Nation. There will be, as time goes on, important events taking place, such as the time we turn on the high power transmitter. I do not know how many million miles out we are going to be able to hear Pioneer V. We think 50 million. That is 4 months from now. Certainly there ought to be a little celebration then, don't you think? And I think we will have one.

Senator SMITH. Yes. I just think we should be shouting from the housetops all the time about it, so at least our own people know what is going on. I am glad to have them know abroad. But it does seem to me that we are a little modest when it comes to publicizing our successes along these lines, and not as modest when it comes to a failure.

Dr. GLENNAN. Well, the same people do not do the talking on those two issues. I would think, Senator Smith, that we could be very vocal about this. I would think that people like yourself, and other Members of the Congress taking part in it, could do this with perhaps better grace than I could, as a matter of fact.

DISCUSSION OF THE DECISION-MAKING PROCESS

Senator SMITH. Dr. Glennan, the Preparedness Investigating Subcommittee of the Committee on Armed Services, and the Committee on Aeronautical and Space Sciences have been having some hearings, and on February 3, in answer to some questions by the counsel, Admiral Rickover said—and I would like to read just a bit of his testimony, if I may take the time, Mr. Chairman.

Senator STENNIS. Certainly.

Senator SMITH. I am quoting from Admiral Rickover:

> I think unquestionably we are ahead of the Russians right now. I also firmly believe that as far as rate of technological progress is concerned, they are ahead.

Then, further on, he says:

> In essence, the contest is really between two different systems of administration, between two different bureaucracies. If we place the issue on that basis, if we stop talking about a contest between democracy and totalitarianism, we can get at the root of the problem and find out why their rate of progress is greater than ours, why they are getting ahead of us. In Russia only the most determined and the most competent people can get the best jobs. If they do not do the job, if they botch a job, they are fired, and if they are fired, they do not have a private company to go to for a job. The Russians do not exercise too much favoritism, either. One of Khrushchev's closest friends was recently removed from the Presidium because he had not done a good job. He did not even get a letter from Khrushchev saying how much he regretted his leaving. He was just told to go. They have the advantage of speed in decision making, the ability to concentrate on a few definite national objectives, to which they apply the necessary energy and resources. They decide what is important technically and industrially, what is important for the political and military power of the state. These items they give national priority. They place a man in charge of a project, they hold him responsible, and they let him alone. If he fails, they get rid of him. They do not hound him day after day and literally prevent him from doing his work, which is the way we treat the men in charge of our large-scale governmental projects. This way of doing business we can no longer afford.

Now, on page 4 in your statement today, you say:

> It is reasonable to assume that the Russians can move more rapidly from concept to drawing board to construction and launching of payloads because they are not limited by the weight restrictions we are experiencing.

Would you care to add anything to that statement of yours, in comparison with what Admiral Rickover has said?

Dr. GLENNAN. Yes. I think, Senator Smith, that we are really talking in two different contexts, because my concern here is more with the technological problem than with this business of management.

The simple fact that they can carry a larger payload, allows them greater flexilibity in the things that they want to put in that payload, the way they want to design them, the weight to be carried, and that type of thing.

So it really is not the same sort of thing that the Admiral was speaking of.

I know in my own mind that some of the things he says are very true. I happen to have visited Russia, as did Admiral Rickover. I am not sure I want to pay the price, or would want the American people to pay the price of the kind of dictatorship that gets things done the way they get them done.

This is a very different world we are living in from the world that the Russian people are living in.

I think our real task is to determine how we can, without damaging the freedoms of our people, move more rapidly. Almost by definition, a democracy requires debate. By definition, a dictatorship permits no debate.

Now, we have managed for many, many years to do very well with the debate. I am not willing yet to give it up. But I do believe that we have a real problem facing us in making it more effective than it is.

Senator SMITH. You would say we are somewhat hampered, then, by a delay in decision, would you not?

Dr. GLENNAN. I think this is right in limited areas.

Senator SMITH. And it took us a considerable time to decide to give the priority necessary for the Saturn problem, did it not?

Dr. GLENNAN. It took all of a week, once the question was raised. I think on the really important and significant things we move rather rapidly.

Senator SMITH. Well, it took a week after the year or two that was required to carry on the discussions.

Dr. GLENNAN. I am not sure whether a priority was ever requested before for Saturn.

Senator SMITH. I think it would be very well for the record, Dr. Glennan, if you would check that, because I think that maybe is not correct, that there is some misunderstanding. I rather gathered that that was an example of what Admiral Rickover was referring to.

Dr. GLENNAN. Well, I think in the case of Saturn, as in the case of many other things, that we, as a people, tend to debate whether there is real value in going ahead with this kind of a project much longer than would be the case in Russia. So I am sure that in the case of the Saturn, the value of the project to the total program, the ongoing program, probably was debated much longer than it would have been in Russia.

Dr. DRYDEN. Largely because it was in the military environment. So the question was, What is the military use of Saturn?

Senator STENNIS. Mr. Lehrer calls my attention to the fact that your statement on formulation of the budget for Saturn should include Mr. Roy Johnson's and Dr. von Braun's recommendations. Will you be sure to include the necessary information as to that?

Dr. GLENNAN. Surely.

Senator SMITH. I am the last one in the world to discourage debate, Dr. Glennan. I want to continue as long as there is any value to it. But when it is time to make a decision, I would make some decision, and I think one of our greatest faults is lack of decision, not only in your line but in many others.

Dr. GLENNAN. I agree with you.

Senator SMITH. But I do not want to shut off debate from anyone.

Dr. DRYDEN. May we clarify that? When we say that the priority was not requested, we mean by people who are in authority. I have no question that people working directly on projects recommend DX priority for all sorts of things. So the question is, when can you say that it has been recommended? We would say that it has been recommended when a conscious management decision has been made. We were replying on the basis of the actions taken by the authorities in the Department of Defense.

Senator SMITH. You may wish to elaborate on that.

Dr. DRYDEN. We can tell you what Mr. Roy Johnson recommended, but he did not have the power, you see, to act in that matter for the Department of Defense.

Senator SMITH. Thank you very much.

Thank you, Mr. Chairman.

NOTE: Mr. Roy Johnson, then Director of ARPA, requested $250 million for Saturn for fiscal year 1961; see footnote p. 58).

Senator STENNIS. Thank you, Mrs. Smith.

Senator Martin, do you have any questions?

NASA INFORMALLY PROVIDED TECHNICAL INFORMATION FOR DISARMAMENT NEGOTIATIONS

Senator MARTIN. The recent discussion here leads me to ask what role NASA is playing in this country in disarmament negotiations.

Dr. GLENNAN. I think nothing.

Dr. DRYDEN. None.

Senator MARTIN. Do you advise our disarmament negotiators on matters involving space?

Dr. DRYDEN. We have some technical input into this. We have been asked for opinions on what it would cost to have certain types of inspection systems, what the satellites would cost, the vehicles would cost. The actual apparatus for detection was, I think, handled by another governmental agency. But we have had a certain technical input into these negotiations.

Senator MARTIN. For information?

Dr. DRYDEN. For information.

Senator MARTIN. On request?

Dr. DRYDEN. On request.

Senator MARTIN. In today's Washington Daily News there is an articles that states—

> The Western Powers today proposed an early East-West ban on space satellites with nuclear warheads as one of the first stages of any disarmament agreement.

Did you have any part in that?

Dr. DRYDEN. We were informed that this proposal was going to be made. Mr. Horner tells me we were actually asked for an advisory opinion, but it was all done informally.

SOME NASA SCIENTISTS HAVE BEEN INVOLVED IN COSPAR WORK

Senator MARTIN. What is the relationship between NASA and the Committee on Space Research?

Dr. DRYDEN. There is no direct relationship. Some of our staff members, as individual scientists, have been involved in the work of COSPAR. Some of our people took part in the scientific symposium which COSPAR held. COSPAR is a nongovernmental organization, a Committee of the International Council of Scientific Unions.

Senator MARTIN. They were sponsors of the IGY?

Dr. DRYDEN. Yes; they were the sponsors of IGY.

MERCURY HAS NOT BEEN DELAYED BECAUSE OF INTERNATIONAL NEGOTIATIONS FOR TRACKING STATIONS

Senator MARTIN. Can it be said in an open session whether there have been any international difficulties concerning placement of Mercury tracking stations?

Dr. DRYDEN. I would say there have been no real difficulties. It has taken some time to have the necessary discussions with the various other countries involved.

Senator MARTIN. Has there been some delay in the Mercury program because of this?

Dr. DRYDEN. No, sir.

Senator MARTIN. It just takes a certain amount of time to work it out.

Dr. DRYDEN. That is correct.

Senator MARTIN. No delay necessarily.

Dr. DRYDEN. So far there has been no delay.

Senator MARTIN. That is all.

Senator STENNIS. Senator Cannon, before I call upon you, I express my regrets that I did not get to hear your comment about this problem of the B–70. I get the impression on the Armed Services Committee that it is one of the very, very serious decisions. I am disturbed that we are not going full blast on developing what is the frontier weapon in the way of a bomber—whatever number it is doesn't matter. But if there is another plateau, new possibilities, I think we ought to emphasize it.

Now, we have a little problem of time here. We want to hear these gentlemen, and I am not suggesting that anyone be brief. Perhaps we can arrange it, however, that some of the questions can be submitted in writing to the witnesses and we can place the answers in the record.

FURTHER DISCUSSION OF THE B–70 PROGRAM

Senator MARTIN. May I ask another question?

Speaking about the B–70, how much money is included in the 1961 budget for the B–70?

Senator STENNIS. Well, there were two prototypes included. They are proceeding with a program to build two prototypes, but the B–70 will not be developed as a usable weapons system, with a bomb-navigation system and other military essentials. So you have, you could say, two pistols without the right kind of ammunition.

Senator MARTIN. I do not have the advantage of the members of the Armed Services Committee, to judge how much is involved.

Senator STENNIS. Well, the amount requested was—do you have those exact figures, Mr. Lehrer?

Mr. LEHRER. The Air Force procurement program for fiscal year 1960, as approved by the Congress, included $346 million for the B–70. The 1960 funding for the B–70 was reduced by the executive branch to $150 million when the decision was made to cancel the B–70 as a weapons system development and reprogram the 1960 funds. That automatically reduced very sharply the additional requirements for 1961 funds, which were cut from the $456 million requested by the Air Force to $75 million. That is in the Department of Defense appropriation bill.

Senator STENNIS. They say that they have postponed a final decision on this weapons system and everything for the B–70 for at least another year, but are going on with two prototype bombers.

Now, my point is that it seems to me like any weapon that might be the ultimate weapon, so far as manned bombers are concerned, that we could not afford to abandon full development of that.

Senator MARTIN. I just wanted to know how much money would avoid that 1-year delay.

Senator STENNIS. Well, I think it was over $500 million to keep the program going.

Is that correct, Mr. Lehrer?

Mr. LEHRER. Yes, sir. The Air Force has lost $577 million in fiscal year 1960 and 1961 funds. It is doubtful that they could recover the time lost by reprograming the 1960 funds. General White testified at the combined hearings of the Space Committee and the Preparedness Subcommittee on February 3, 1960, that it would require some $360 million to reinstate the B–70 as a weapons system development. Of course, it takes not only the money, but a decision by the executive branch to reverse itself and to change the nature of the program. Putting the money in the appropriation bill will not accomplish anything by itself.

Senator STENNIS. Well, it was between $400 million and $500 million that would have been required in fiscal year 1961 to have continued the B–70 as a weapons system and give it the full green light. As it was, they gave it $75 million to keep development going of the two prototypes and defer for 1 year the decision as to developing the B–70 as a useful bomber.

Senator Young, do you have any further questions now?

Senator YOUNG. Are you finished?

Senator STENNIS. I think we are about through.

Mr. Lehrer has some questions.

Do you have some more questions for Dr. Glennan?

Senator YOUNG. I have a few.

Senator STENNIS. All right.

SATURN STATIC TEST SCHEDULE

Senator YOUNG. Dr. Glennan, I forgot to ask you before, on page 5 of your statement, in mentioning the Saturn time schedule, you indicate a static test of eight engine clusters in the spring of 1960.

Now, do you mean the whole engine, or only a part?

Dr. GLENNAN. We expect to fire two engines, then four engines, then eight engines, in the cluster. That will be accomplished in the spring.

Senator YOUNG. Well, today seems like spring.

When do you think it will be accomplished?

Dr. GLENNAN. Well, we fired two of them today.

Senator YOUNG. It is on schedule, is it?

Dr. GLENNAN. It is ahead of schedule although it depends on what schedule you use. But to us it is ahead of schedule.

Senator YOUNG. Do you expect it will be within the next 60 days?

Dr. GLENNAN. General Ostrander guesses that is a reasonable figure.

RELATIONSHIP BETWEEN NASA AND PRIVATE COMPANIES IN DEVELOPMENT OF COMMUNICATIONS SATELLITES

Senator YOUNG. During our hearings last year, we discussed the efforts being made by a commercial company in the field of communication satellites.

Now, on page 719 of last year's hearings, Senator Stennis asked you:

> The commercial companies are following the possible applications of communication satellites very closely, I imagine, aren't they?

And you said, "Yes, sir."

And then he asked:

> And have some of them their own experiments? Are they getting into that field themselves?

And to that question from the chairman, you said:

> Yes, we have under negotiation at the present time a contract for cooperation with at least one of the large commercial companies in the communications field, and they are spending their own money, sir.

Senator Stennis said:

> That is the American Telephone & Telegraph Co.?

And you said:

> Yes, sir. Invitations, by the way, are being given to other companies in the field to join us on this, as well.

Now, Dr. Glennan, that leads to my question.

Could you tell us what has happened in this respect since then, if anything?

Dr. GLENNAN. Yes. The cooperation continues with the Bell Telephone people. They have built receiving equipment and transmitting equipment, at their laboratory location in New Jersey. They have talked back and forth to our station at Goldstone Lake, in California, via the Moon, using that body as testing device for our satellite experiment later on. They have achieved very excellent voice transmission between New Jersey and the Boston area using the balloons we have put up off Wallops Island in test launches. They will be involved in a good many of these same experiments, just as soon as we put the Echo satellite in orbit, which will be later this spring.

Senator YOUNG. Now, that leads me to this question:

Do you anticipate, Dr. Glennan, that there will be a time in the future when private companies will send up their communication satellites?

Dr. GLENNAN. I would seriously question private companies sending up or using a launch vehicle system of their own, developing one, which would put these satellites into orbit. There is no reason, however, to doubt the probability that they would design the space craft and build those, which would then be launched by a governmental agency.

Dr. DRYDEN. Senator Young, could I add this:

The Congress reserved to itself this matter of policy on operations. NASA was authorized to operate space craft for research purposes. I think that ultimately this question will be settled by Congress. Certainly the property rights in a satellite system will be so great that the Government will exercise a great deal of control over it. The mechanism has not yet been determined by the Congress.

Senator YOUNG. Yes, I understand that.

Now, Dr. Glennan, what do you conceive in that connection to be the proper relationship of government and private industry as we go down the road, in developing communication satellites for commercial use?

Dr. GLENNAN. I think, Senator Young, that it must be a completely cooperative venture, into which I would expect the communications companies to be putting increasing amounts of money, very frankly.

OFFICE SPACE A PROBLEM AT NASA

Senator YOUNG. Now, one final question, and this isn't as important, I don't think, as the other questions. But last year—I am curious about this—last year the Congress amended the Space Act to authorize the lease of consolidated space for your headquarters in Washington for a period not exceeding 10 years. While this amendment was approved as a temporary expedient to relieve your agency of unsatisfactory working conditions, the committee went on record that GSA should take prompt action to provide suitable space for NASA in Government buildings to be constructed in the future.

Now, I say this is not perhaps as important as some of these other questions, but it is of some importance.

What is your present situation in respect to office space?

Dr. GLENNAN. It may not be as important as some of the technical questions, but it is certainly important to get this job done. We have been promised space in Federal Office Building No. 6, which is scheduled for completion in the middle of 1961, a little over a year from now. In the meantime, we have most recently been given by the GSA about half of a building in the District, which they had under lease. These quarters having been previously occupied largely by State Department personnel now moving into the new State Department Building.

If we are able—and it seems we will be—to occupy that space on schedule between now and May 15—we started moving yesterday—I think we will be reasonably well taken care of.

The Beltsville buildings are beginning to come into use. I think by May 15 the first small group will go out there, and perhaps by the

middle of the summer a fair number of our Goddard space flight people will be housed in their permanent buildings at Goddard space flight center. So we are getting some relief.

But it has been a very rugged winter, believe me.

Senator YOUNG. Well, here in Washington the urgency is so extreme—what are the facts here? Do you think that the GSA could do better for you than to make you wait until 1961?

Dr. GLENNAN. I do not believe they have any space that will help very much our present situation, because there is no space that I know of. I think I am right about this. There is no space that would house the entire group.

Senator YOUNG. Well, instead of taking further time now, would you be willing, Dr. Glennan, to make inquiry, to supplement any information you have at the present time, and then file that with us and make it a part of the record?

Dr. GLENNAN. Yes. I have a statement here of all the office space that we presently have, and that we will occupy through this summer.

Senator STENNIS. All right, without objection we will put that in the record.

(The information referred to is as follows:)

CHRONOLOGY OF NATIONAL AERONAUTICS AND SPACE ADMINISTRATION OFFICE SPACE NEGOTIATIONS

Shortly after the creation of the National Aeronautics and Space Administration in October 1958, negotiations were opened with the General Services Administration to obtain as soon as practicable a suitable permanent headquarters building for NASA, and also to achieve, meanwhile, an immediate temporary solution to meet growing staff demands.

PERMANENT HEADQUARTERS

In December 1958, NASA was advised by GSA to seek an amendment to the National Aeronautics and Space Act of 1958 so that NASA funds, through the Administrator of General Services, could be used to lease buildings for use in the District of Columbia. This authority was granted by the Congress in April 1959. GSA then had no available federally owned or leased space to meet our needs, so that commercially owned buildings were examined and a building identified as satisfactory. In July 1959, however, GSA found it would have some 97,000 square feet of Government-leased space vacated in April 1960. GSA offered this building (the Maiatico Building) as an NASA headquarters; despite the fact that it would not house the entire headquarters staff, NASA felt obliged to accept. A letter dated July 1, 1959, (see attachment No. 1) formalized this commitment and also indicated GSA's intention to provide NASA with space in Federal Office Building No. 6 when it was ready in July 1961. This was the first indication that space in a first-class Government building could be made available. Therefore, upon reconsideration, NASA made the following proposal that if GSA would make a firm commitment on adequate space in Federal Office Building No. 6, NASA would avoid a double move by remaining in its scattered locations until Federal Office Building No. 6 was ready, provided GSA would assure such additional temporary space as might be required prior to the permanent move.

This proposal was accepted by GSA on October 12, 1959, and 130,000 square feet of space in Federal Office Building No. 6 was assigned to NASA (see attachment No. 2). Subsequent program developments, however, considerably increased the headquarters staff requirements. Particularly, the new responsibilities the President assigned NASA in the development of launch vehicles of very high thrust and the takeover of the 5,500-man Von Braun organization from the Army has had an impact on the headquarters staffing beyond what can be efficiently housed within this area. A formal request of March 14, 1960, for 12,600 square feet of additional space in Federal Office Building No. 6 is now pending with GSA.

TEMPORARY OFFICE SPACE

Concurrent with permanent headquarters negotiations, NASA has also had to provide itself with additional temporary office space to keep up with its increases in the headquarters staff on duty. Negotiations with GSA produced 23,000 square feet of Government-owned space in April 1959, putting NASA in four scattered buildings and some 80,000 square feet of space. In early November 1959, after the Huntsville transfer, NASA requested that GSA provide additional temporary space to meet our headquarters needs for fiscal year 1960 and fiscal year 1961 until Federal Office Building No. 6 was available. GSA stated that no federally owned space was then available and asked NASA to submit a formal request for the leasing of more space. The GSA central office then approved the undertaking of negotiations by its regional office on a building near our present main location. Two months later (January 1960) it developed that this building could not be leased within the legal limitations of the Federal Economy Act. Similar negotiations on a second building were unsuccessful for the same reason. In February negotiations were started on a third commercial building then nearing completion. The GSA regional office committed itself in writing to NASA to lease space in this building on February 4, 1960. In the case of each of these three buildings, NASA technical and adminstrative personnel developed detailed layout and occupancy plans in order to be able to move in as soon as possible after the lease was signed.

On February 15, 1960, however, the GSA Commissioner of Public Buildings notified NASA that he could not approve the leasing plans of the regional office. His initial alternative proposal was to undertake leasing arrangements on competitive bidding, rather than negotiation.

Subsequently, however, the GSA Administrator found GSA was able to obtain space in another Government-leased structure which would soon be vacated by elements of the State Department (see attachment No. 3). On February 29, 1960, he officially assigned to NASA some 52,000 additional feet of space in this building (801 19th Street, NW.).

In early March, one further complication arose when the newly created Inter-American Development Bank stated that it had a GSA commitment for some of the same space as had been assigned to NASA. This problem was resolved by a meeting which was held on March 10 at the White House with the following in attendance:

1. Mr. Robert Merriam, special assistant to the President
2. Mr. Franklin W. Floete, GSA Administrator
3. Dr. T. Keith Glennan, NASA Administrator
4. Mr. Robert Cutler, Executive Director, Inter-American Development Bank
5. Mr. W. O. Trone and Mr. C. A. Shinkwin, representing the State Department—present occupants of the building

An agreement was concluded which provided for a distribution to NASA and to the Bank of State Department space as it became vacant, with the bulk of the space becoming available by May 15, 1960. This delivery schedule, however, is subject only to change if the scheduled completion of the New State annex by the contractor is delayed.

The first of a number of moves of NASA staff to the new location took place at the end of March.

[Attachment 1]

GENERAL SERVICES ADMINISTRATION,
Washington, D.C., July 1, 1959.

Hon. T. KEITH GLENNAN,
Administrator,
National Aeronautics and Space Administration,
Washington, D.C.

DEAR DOCTOR GLENNAN: This confirms recent agreements concerning the most practical means of satisfying the space requirements for the National Aeronautics and Space Administration.

The Maiatico Building at 800 Connecticut Avenue containing approximately 97,000 net square feet will be assigned to NASA as soon as it becomes available. This space, currently occupied by the International Cooperation Administration,

is to be vacated the latter part of fiscal year 1960 upon completion of the new State Department building. Space totaling some 33,000 net square feet is currently assigned to your agency in the Wilkins building at 1512 H Street NW. Occupancy of this space may be retained in addition to space in the Maiatico Building if this quantity of space is needed to adequately accommodate your staff before permanent housing can be provided in a new Federal office building.

It is understood that rental costs for space in the Maiatico Building will be financed by NASA in fiscal year 1960 for whatever portion of the fiscal year it may be assigned space in the building. Rental costs for this space in fiscal year 1961 will be included in General Services Administration's budget estimates which are to be submitted to the Bureau of the Budget this fall.

Office space for NASA will be provided in Federal Office Building No. 6, or such other new Federal office building to be scheduled for completion by 1963. More specific information in this regard should be available prior to your occupancy of the Maiatico Building next spring.

A number of adjustments, including improved air conditioning in selected areas and changes in floor layout and partitions in the building, will be necessary to accommodate your needs. Plans for these changes will be coordinated with your representatives. The extent of the changes should be agreed upon only after carefully considering the period this space is to be occupied pending completion of space for NASA in a new Federal office building. Based on our discussions, I am sure that you will want to weigh the economic considerations involved and request only those modifications which are determined to be essential to your operation during the period of occupancy.

Costs for the partitioning and other changes not provided by the lessor will be financed by GSA in accordance with our agreement.

Sincerely yours,

FRANKLIN FLOETE,
Administrator

[Attachment 2]

GENERAL SERVICES ADMINISTRATION,
Washington, D.C., October 12, 1959.

Hon. T. KEITH, GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

DEAR DR. GLENNAN: We concur in the proposal outlined in your letter of September 29 whereby the National Aeronautics and Space Administration will continue occupancy of space now assigned to it for its headquarters operations until FOB No. 6 is ready for occupancy in 1961, at which time its requirement for approximately 130,000 square feet of space will be met by the assignment of space on the fifth, sixth and seventh floors of FOB No. 6, with the exception of approximately 5,000 square feet of storage space in the basement to be used for this purpose.

It is my understanding that under space assignment plans which our regional office staff has discussed with your staff the space assignment by floors is as follows:

	Square feet
7th floor	36,485
6th floor	50,720
5th floor	38,050
Basement	5,000
Total	130,255

Early approval of space assignment plans for the above-mentioned space furnished to your staff by our regional office on September 10, 1959, will assure completion of the interior layout in coordination with the remainder of the building.

Sincerely yours,

FRANKLIN FLOETE, *Administrator.*

[Attachment 3]

GENERAL SERVICES ADMINISTRATION,
Washington, February 25, 1960.

Hon. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

DEAR DR. GLENNAN: Arrangements have been made to assign space to the National Aeronautics and Space Administration at 801 19th Street NW. in accordance with your letter of February 18 and our subsequent telephone conversation. We believe that this will quite satisfactorily solve the space problem you described without the necessity of consummating an additional lease for office space in the District of Columbia.

There will be the entire second floor and 1,400 square feet of space on the first floor available to you by March 15. The balance of the requested 52,000 square feet will be available by May 15, on the 9th, 10th, and 11th floors.

Regional Commissioner Daly will continue to work with your representatives to effect a phased assignment at that location to meet your expansion.

Sincerely yours,

FRANKLIN FLOETE, *Administrator.*

Senator STENNIS. Gentleman, we have Dr. Dryden here now, who has some special remarks. He has a matter of interest I think.

However, Senator Cannon tells me he has another question for Dr. Glennan. Please proceed, Senator Cannon.

MERCURY BALLISTIC SHOT WILL TAKE PLACE WHEN READY

Senator CANNON. Thank you, Mr. Chairman.

Dr. Glennan, Senator Smith raised a question that I had not heard before, and I wanted to develop the answer a little. She said she had heard a statement that there was a possibility of this Mercury ballistic shot, of our first man into space, occurring immediately prior to election this fall. You answered—and properly so—that you certainly would not take a chance with a man's life on that type of a consideration. However, that left unanswered in my mind the problem as to when you will be ready to make this shot. I assume if you were ready and felt that you had taken all of the safety precautions, you would make that shot, even though it might occur prior to election, unless you know now that you will not be ready until after that time.

Dr. GLENNAN. You are perfectly right. We will make the shot when it is ready to go.

What I was trying to convey, Senator Cannon, was that I do not believe that in a program of this kind political considerations should get involved in scheduling that kind of activity.

Senator CANNON. I agree with you. But you were not leaving the impression that this shot would not be made until after election?

Dr. GLENNAN. No, sir.

Senator CANNON. Thank you very much.

Senator STENNIS. Thank you, Senator.

All right, Dr. Dryden. Do you want to proceed now? You do not have a prepared statement, as I understand.

DR. DRYDEN DISCUSSES INTERNATIONAL ACTIVITIES

Dr DRYDEN. No; I do not.

First I want to say just a word about our international activities. As you know, the Congress was very much interested in the possibilities of using the space program as a vehicle for cooperation with other countries. We have taken the initiative in this. We have held many discussions with representatives of other countries. We think that the efforts so far have paid off.

As you know, the Soviets, after boycotting COSPAR, finally came into that nongovernmental organization. They also began to announce their launchings on the day of launching. We believe that these are payoffs from the policy of openness in the space program which Congress recommended and authorized.

At the present time there are cooperative activities under way with the United Kingdom and with Canada. I won't take the time to describe them here. We had a Japanese delegation here a few weeks ago, and at this very moment there is an Italian delegation—headed by Professor Broglio, chairman of the Italian Space Committee—exploring the possibilities of their cooperating in the sounding rockets program.

In general, we have taken the view that it is not our place to tell these countries what they ought to be interested in. We do not want to hire their people to do something that we want them to do, whether they want to do it or not. Instead, it is our desire to get into a truly cooperative program, in which they pay their way and we pay ours. The bills are quite diverse in size—but it is a cooperative effort between the two groups.

We think it is of benefit to us to bring in scientific ideas from other groups, and it is of benefit to them for some of their people to work with our groups and gain some experience in our laboratories. We think the effect of this open-door policy has been to add to the climate of good will among all our friends. We think the benefits have increased by comparison with the opposite policy of the U.S.S.R. As you know, they have been quite tight with information on the space program.

With that little rundown on the international program, I want to report on how we spent our money last year—what we got out of it in the way of flights.

RÉSUMÉ OF NASA'S 1959 LAUNCHINGS

There are listed on this chart the major launchings by NASA during calendar year 1959. The successes are shown in black type, and the failures in lighter type, indented.

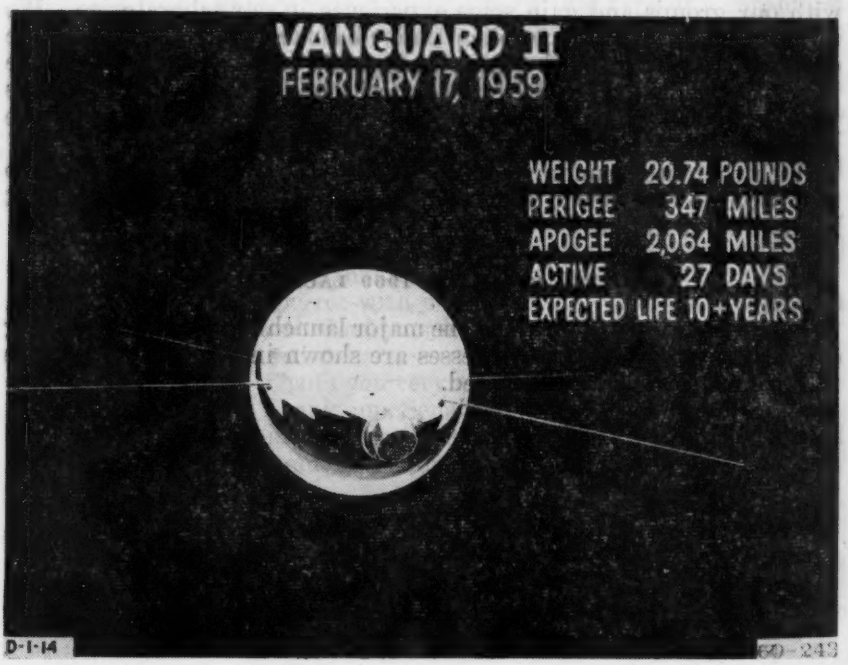
53795—60—pt. 1——6

(Chart 4, Major NASA Launchings, calendar year 1959:)

CHART 4

MAJOR NASA LAUNCHINGS
CY 1959
FEB 17 VANGUARD II SATELLITE
MAR 3 PIONEER IV LUNAR PROBE
APRIL 13 VANGUARD
JUNE 22 VANGUARD
JULY 16 JUNO II
AUG 7 EXPLORER VI SATELLITE
AUG 14 JUNO II
AUG 21 LITTLE JOE
SEPT 9 BIG JOE MERCURY SUBORBITAL
SEPT 18 VANGUARD III SATELLITE
SEPT 24 ATLAS ABLE
OCT 4 LITTLE JOE MERCURY SUBORBITAL
OCT 13 EXPLORER VII SATELLITE
NOV 4 LITTLE JOE MERCURY SUBORBITAL
NOV 26 ATLAS ABLE
DEC 4 LITTLE JOE MERCURY SUBORBITAL
D-1-14
60-242

CHART 5



The launchings, of course, are the visible sign to the public of what we are doing. There is a great deal under the surface which goes to back up these activities in our own laboratories, and particularly in the laboratories of industry under contract.

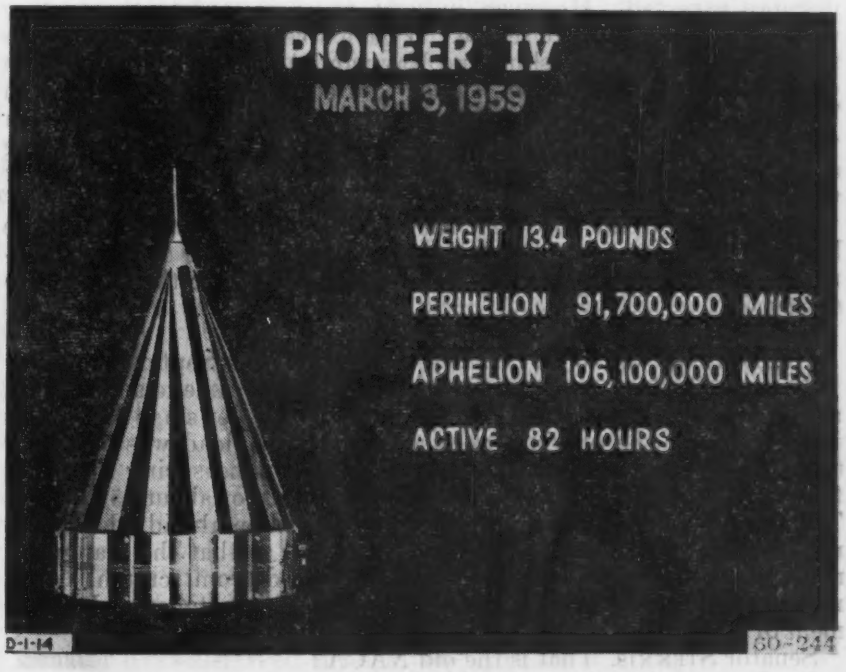
Last year we came before you and all we could talk about was what we were going to do. We were only a few months old. This year we can tell you about some of the things we have done.

We have made a start. We have developed the long-range plan which Dr. Glennan has reviewed for you. While we are proceeding intensively to develop boosters of larger capacity, we are using those that we have to gain experience and information about space.

There have been 16 launchings. On February 17, 1959, there was a successful launching of Vanguard II, the second of the Vanguards to be successful (Chart 5, Vanguard II). This carried two infrared cells to scan the cloud cover of the Earth. The instrumentation worked perfectly. We had some vehicle trouble, in that there was a collision between the two stages which caused the satellite to wobble. We are still struggling with the problem of determining in what direction the satellite was looking when the measurements which have been radioed back to Earth were made. This was the first attempt toward development of a cloud-cover satellite. It was successful, except for this wobble and a very difficult data reduction problem.

On March 3, Pioneer IV was launched into orbit around the Sun. This was the vehicle which held the record for communication distance up until Pioneer V came along. We maintained communication with Pioneer IV for 407,000 miles and returned data from experiments (chart 6, Pioneer IV).

CHART 6



Then, as you see, we had a very disappointing period. On April 13 a Vanguard failed because of some difficulty with the operation of the second stage, which tumbled and fell into the ocean.

On June 22, a helium pressure regulator failed in another vanguard launching attempt, and the flight was unsuccessful.

On July 16, a Juno II—failed. The guidance power supply failed. As you recall from the pictures, the vehicle turned over very sharply a short distance up in the air—5½ seconds off the pad—and was destroyed by the range safety office.

On August 7, Explorer VI was launched into an elliptical orbit, going out to a distance of 26,000 statute miles, carrying 14 experiments.

On August 14, again there was a failure of a Juno II. Apparently something went wrong with the attitude control on the upper stages, and the control malfunctioned. This particular one carried a 12-foot sphere with which we hoped to make air density measurements.

On August 21, in one of the early experiments aimed at checking out some of the Mercury equipment using the Little Joe booster rocket, the escape rocket attached to the capsule fired half an hour before the launch time, while the assembly was sitting on the launch pad. This was a test of the capsule escape system, and when the escape rocket fired, it took the capsule off the top, leaving the Little Joe booster sitting on the ground. This was traced to a wiring error—a human error. That flight was repeated successfully a little later.

On September 9, we conducted an experiment that gave us a big uplift. This was a test of the "boiler-plate" Mercury capsule on the Atlas. You may recall this experiment. There was a little malfunction on the Atlas in that the two motors did not drop off, so the trajectory was not quite that planned. Particularly it did not go the distance expected. However, in some ways, related to the heating encountered, it was more severe. It gave a very good workout to the recovery system. Navy ships and Navy and Air Force airplanes were deployed according to plan. They located the capsule in about an hour and recovered it in six hours, which was very encouraging. In particular, our planning with the Department of Defense for getting a man back from one of these capsules seemed to be working out fairly well.

As you know, the capsule came down in perfect condition. The heat shield did protect the interior. As one of the astronauts remarked, it would have been possible for him to be in there in entire safety.

Senator STENNIS. What was that, Big Joe?

Dr. DRYDEN. What we call Big Joe. That was September 9.

Then, on September 18, the Vanguard program came to a close with another success—Vanguard III. This had an upper stage a little bit improved over the previous ones, so that the payload was 50 rather than 20 pounds. This carried experiments for measuring magnetic fields. This gives the Vanguard an overall score of about 35 percent. The score of many of the other programs based on already developed missiles has been about 50 percent successful, so that the Vanguard record was pretty good for a device developed from scratch. As a matter of fact, it is pretty comparable with the early stages of development of other vehicles.

Senator STENNIS. That is the old NACA?

Dr. DRYDEN. No, this is the old Naval Research Laboratory project.

Senator STENNIS. Yes, that is right.

THE VANGUARD PROGRAM HAS MADE A RICH CONTRIBUTION TO THE U.S. SPACE PROGRAM

Dr. DRYDEN. As you know, payload experiments designed for Vanguard were used in Explorer I, the first U.S. satellite. The tracking network set up under Vanguard is the basis of our present tracking network. The second stage of the Vanguard vehicle has been used in other vehicles, and so has the third stage. So we got a lot of good out of the pieces of Vanguard in successive programs.

On September 24, we had a disappointment. During a static test of the Atlas-Able, which is Atlas with the second-stage of Vanguard, the vehicle caught fire and was destroyed. The payload did not happen to be on that one. We had that much good fortune.

On October 4, the Little Joe flight of the Mercury capsule was made. The test was completely successful.

On October 13, Explorer VII, a 91½-pound satellite with five experiments was launched. It is still sending data to us.

On November 4, another Little Joe test was made, this one simulating an aborted flight of the Mercury capsule.

On November 26 there occurred the Thanksgiving incident you heard about—a very disheartening experience. Although many wind tunnel measurements had been made of loads on this vehicle over a wide range of speeds, it happened, unfortunately, that the peak load occurred at a speed in between two at which the measurements had been made. This kind of result is quite disheartening, but the same thing will not happen again. Once you know the causes of these incidents, you can take the steps to eliminate them.

On December 4 there was another Little Joe experiment, simulating abort of the Mercury flight at a high altitude—in other words, if the astronaut got into trouble high up in the atmosphere. This one carried a monkey. The separation of the capsule took place at 100,000 feet. It coasted on up to 278,000 feet. The capsule was recovered 177 miles from Wallops by the Navy recovery group.

To bring the record up to date, on January 21, 1960, there was another Little Joe shot, an abort test at an altitude where the air density was high. This also carried a monkey, and was recovered safely.

On March 11th Pioneer V, which you have heard about, was launched. It will go about 18 million miles closer to the Sun than the orbit of the Earth. It is the first probe fired inward, toward the Sun. The other artificial planets are between the orbit of the Earth and Mars, fired outward. This one is in between the Earth and the orbit of Venus. It carries a considerable number of experiments.

At two o'clock today it was 2,402,800 miles from the Earth, and it is expected to pass 3 million miles early Saturday morning, April 2, about 4:10 a.m.

We will, in a couple of weeks, turn on the larger transmitter which should, if it works, take us out in the neighborhood of 50 million miles, which would be quite a distance for transmitting data.

We have a duplicate of Pioneer V here without the paddles. The paddles are in a box between New York and here. The two boxes were shipped together, one of them came, the other was delayed. We hope they will be here tomorrow.

Senator STENNIS. Well, I hope you let us see it.

Dr. DRYDEN. We have for you a tape recording of the communications received from Pioneer V at the end of a million miles.

(The tape recording was played.)

Senator STENNIS. Was that recorded from one of our receivers, or from the one in England?

Dr. DRYDEN. The receiver in Hawaii was being used in this particular reception. As we get further out, it will be picked up only in England.

Senator STENNIS. Yes, that is what I heard.

All right, Doctor.

Dr. DRYDEN. I did not show you pictures of all the successful satellites, just to save your time. There is a set of charts which shows them. We can give them to you, if you want them for the record.

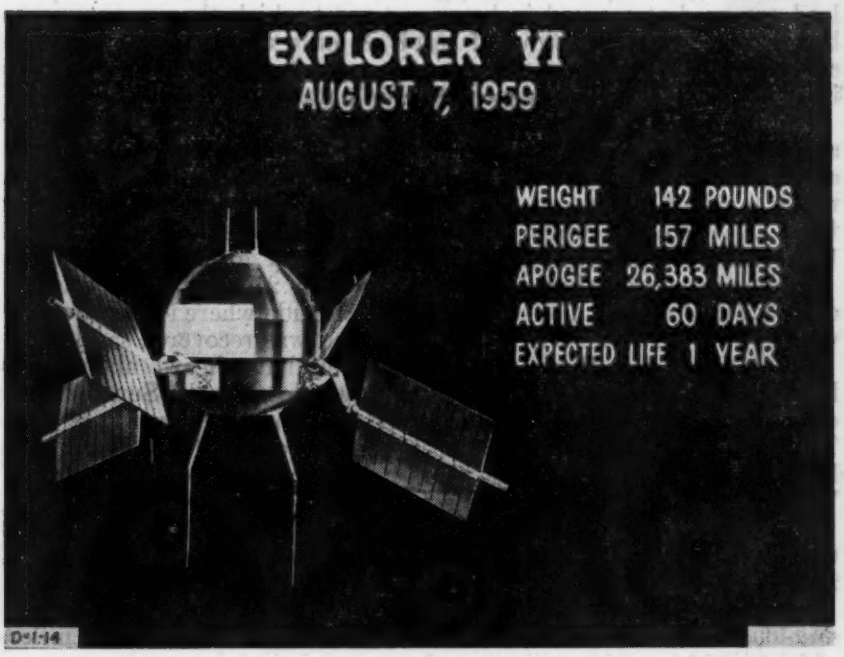
Senator STENNIS. I would like to have you discuss the expected life for each one.

Dr. DRYDEN. The satellites still in orbit are Vanguard I, II, and III, and Explorer I, VI, and VII.

Sputnik III is due to come down at the end of this week, or the first of next week, and then there will be no U.S.S.R. satellite still aloft.

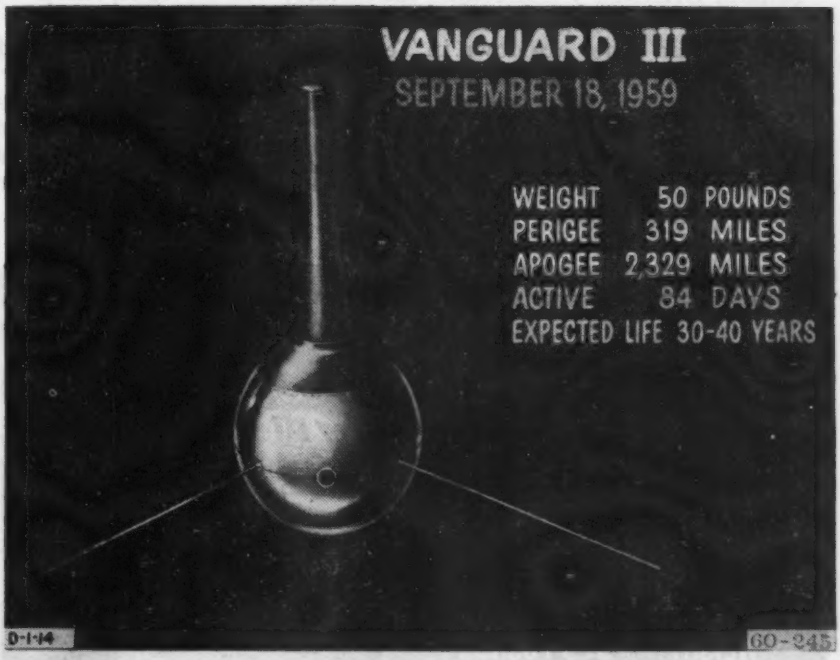
Explorer VI has paddles very much like Pioneer V, and its weight is 142 pounds (chart 7, Explorer VI).

CHART 7



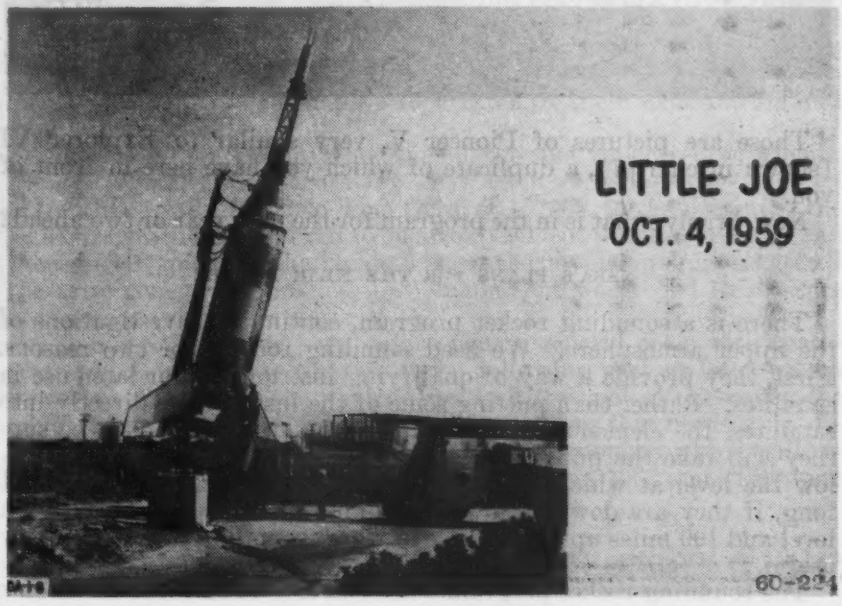
Vanguard III has a magnetic instrument out at the end of a long plexiglass tube, to get it away from magnetic material in the body of the satellite itself. It will stay up 30 or 40 years (chart 8, Vanguard III).

CHART 8



This is a picture of Little Joe. I mentioned that these escape rockets fired prematurely in the first one. Later we had successes. Two of the capsules carried monkeys (chart 9, Little Joe).

CHART 9

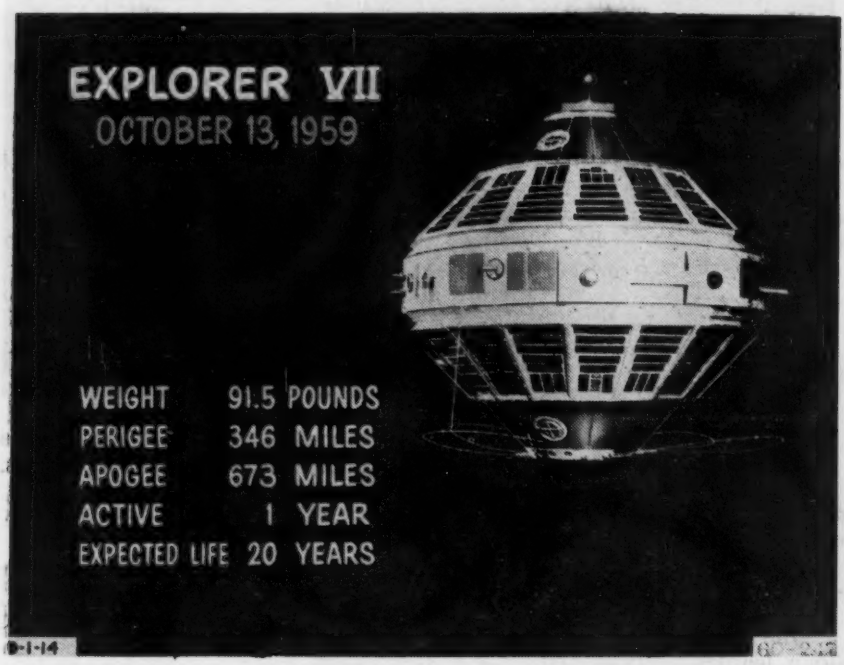


Senator STENNIS. I understand the monkey was all right, except he was hungry. What has become of him? Is he still living?

Dr. DRYDEN. They are down in Texas at the Air Force's School of Aviation Medicine in San Antonio.

This is Explorer VII, the one which carried a large number of experiments. The batteries have solar cells. The transmitter will be kept on for a year, and then it will be shut off to prevent interference with radio transmissions from other experiments (chart 10, Explorer VII).

CHART 10



Those are pictures of Pioneer V, very similar to Explorer VI (shown in chart 7), a duplicate of which you have here in front of you.

Now, briefly, what is in the program for the next year or two ahead?

NASA'S PLANS FOR THE NEAR FUTURE

There is a sounding rocket program, continuing investigations of the upper atmosphere. We need sounding rockets for two reasons. First, they provide a way of qualifying instruments for later use in satellites. Rather than putting some of the instruments directly into satellites, the elements are tried in the sounding rockets to be sure they will take the punishment. Second, we want measurements below the level at which satellites can survive. Satellites do not last long, if they are down as low as 100 miles. The space between sea level and 100 miles up is the space in which sounding rockets are very useful.

The sounding rocket program will be at a level of about 100 flights per year. Many of the flights are made at Fort Churchill, with the

cooperation of the Canadians. Some are made at Wallops Island. A few are made at other locations.

In the satellite program, we will keep on at about the same rate as the last half of last year. We have had 10 attempts last year with 4 successes.

Last year we launched one space probe. We will continue with probes, with emphasis, in our forward program, in the neighborhood of the Moon.

PROJECT ECHO—PASSIVE COMMUNICATIONS SATELLITE

We have mentioned the communications application. Some of you may have seen the shots preliminary to project Echo, which have been visible up and down the whole Atlantic coast, in which the 100-foot aluminum-coated plastic sphere was launched in a ballistic path to altitudes of 250 miles, at a speed of about 9,000 miles per hour.

There will be Echo shots during this year, and others next year. We wish to learn, first of all, whether this balloon will actually stay up for some length of time and whether it will retain its spherical shape. The object of this research, in other words, is to determine whether you can build a passive satellite communication system.

TIROS AND NIMBUS METEOROLOGICAL SATELLITES

There are two meteorological shots this year, in project Tiros, which is the satellite carrying a television camera to transmit back pictures of clouds.[1] It is a spin-stabilized satellite. As it goes around the Earth, it will be looking at the Earth half the time.

This will be followed in our meterological program by a satellite we call Nimbus, which will be stabilized so that it is always looking at the earth as it goes around. This requires attitude control which is not present in the earlier vehicles.

You have heard so much about project Mercury, I do not believe that I will attempt to review that.

One thing which I do want to emphasize in this discussion is the long leadtime involved in the preparation of these experiments and their launch vehicles.

Actually, as Dr. Glennan mentioned, the shot which was just made, Pioneer V, was authorized a few days after we took office.

In other words, the time from October 1, 1958, to the present is the leadtime which was required to do an experiment when we already had the vehicles, and all we had to do was get the payload going and get all the arrangements completed, tests made that we needed to reassure ourselves that it would work.

The budget that you have before you in general deals with spacecraft which will not be fired until the following year or later. Such items are included as the payload for an astronomical telescope—the advanced satellite required for that is something that needs to be developed now. In fact, the studies by the astronomers which will result in this firing of an astronomical telescope in 1962 and after were started last year.

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[1] Tiros I was successfully launched on April 1, 1960, and is successfully sending back a large number of exceptionally good cloud cover photographs. See also note on p. 31.

ADVANCED LUNAR MISSIONS

Now I would like to discuss our advanced lunar missions. We talked earlier about hitting the Moon. It is like going to the North Pole for the first time. Just hitting the Moon really accomplishes very little, except perhaps psychologically. Instead, we would like to go to the Moon and make experiments on the surface. We would like to have a picture of the Moon as we are coming in close to it. We would like to analyze the rock of which it is composed. There are a great many things that are going to have to be done and can be done with instrumented packages which are landed on the Moon.

As has been remarked, we need a little greater thrust capacity in order to be able to do that kind of mission with assurance. But one landing on the Moon does not end for all time the accomplishments and the benefits to be gained by further landings.

Our total program, then, includes about 30 major launchings per year.

You have heard about the vehicles which are involved. The program provides for continuation of Atlas-Centaur at a good pace, the acceleration of Saturn, the initiation of work on the upper stages of Saturn, additional money on the F–1 engine, additional money for Project Rover, and the program for auxiliary power, which will be described in more detail. Pioneer V is using solar cells to charge batteries, which is all right for a small amount of power, but you need more in later missions. We have to go to nuclear power, probably, with the heat from a reactor driving an electric generator. Our program provides for such developments, which will take 3 or 4 years to bring to fruition.

We have also studies in electrical propulsion, which is some distance into the future, but it is a system which will become needed in space as we get away from the immediate neighborhood of the Earth.

I have given you a very quick rundown of what the budget covers in the way of an immediate program. The other speakers, under Mr. Horner's direction, will describe this program for you in much more detail.

JODRELL BANK RADIOTELESCOPE MAY HEAR PIONEER V UP TO 60 MILLION MILES

Senator STENNIS. All right, Doctor. We are always very much interested in anything you have to say.

Now, in connection with Pioneer V, how far out can we hear it with our own equipment? What plans are you making in this connection?

Dr. DRYDEN. Assuming successful operation of the 150-watt transmitter, the 60-foot antenna located in Hawaii should be able to communicate with the probe up to a range from 15 to 25 million miles from the Earth. The Hawaii installation will communicate with Pioneer V daily until the probe goes out of its range.

The Goldstone 85-foot antenna will also be used to communicate with Pioneer V from time to time but will not be used on a regular

schedule because of other work schedules. This installation can communicate over somewhat longer ranges than the Hawaiian station.

Lastly, the Manchester facility, also known as the Jodrell Bank radiotelescope, with a 250-foot antenna is expected to communicate daily with Pioneer V up to a range of 40 to 60 million miles providing the Pioneer transmitter does not fail before it reaches that distance. NASA provides financial support for operation of this facility for NASA flights.

Senator STENNIS. Do you plan to utilize the Navy's big 600-foot radiotelescope when it is finished in 1962? Have you had any talks or agreements with the Navy people on this?

Dr. DRYDEN. Yes; it is anticipated that NASA will make use of this equipment insofar as scheduling and other technical considerations permit. We have had discussions with personnel associated with and directing the 600-foot antenna project and plan to continue these discussions when the construction and operational schedules at this installation become more firm.

Concerning the tracking of Pioneer V in 1962, we have been told by Dr. George Mueller, Vice President of Space Technology Laboraties, that the probability of the Pioneer's transmitter remaining operable until 1962 is infinitesimal. Therefore, there appears to be virtually no possibility of tracking Pioneer V with the 600-foot antenna in 1962.

SPACE PROBES NO GOOD UNLESS DATA CAN BE RETRIEVED

Senator STENNIS. What good does it do to send a probe into deep space if you cannot retrieve the data from it?

Dr. DRYDEN. It does no good. In the case of Pioneer V, the Space Technology Laboratories have computed the expected lifetime of the transmitter to be less than 6 months, in which case transmitter failure should occur at approximately the same time as the vehicle reaches the limit of the Jodrell Bank tracking facility.

For future space probes, improved vehicle antennas and higher radio frequencies will be used so that communication ranges of several hundred million miles will be possible with the 85-foot antennas now at Goldstone and the two additional similar antennas planned for Australia and Africa.

Additional research and development on larger antennas is being conducted and such antennas will be budgeted for when they are needed by the NASA space program.

Senator STENNIS. Thank you, Dr. Dryden.

We will see now if there are any additional questions.

Senator Martin, do you have some questions for Dr. Dryden?

Senator MARTIN. No, Mr. Chairman.

Senator STENNIS. All right.

Senator Young?

Senator YOUNG. I have none now, Mr. Chairman.

Senator STENNIS. Senator Smith has left some questions here, Dr. Dryden. Will you please answer these so that they may be inserted in the record?

Dr. DRYDEN. Surely.

(The material referred to is as follows:)

NASA PARTICIPATING IN PLANNING FOR U.N.-SPONSORED INTERNATIONAL SPACE CONFERENCE

Question No. 1. As you know, the United Nations has passed a resolution calling for an International Space Conference sometime in 1960 or 1961.

(*a*) What part does NASA play in planning for and participating in this conference?

(*b*) Who will cover the expenses involved in this Conference, NASA or the State Department?

Answer No. 1(*a*). NASA has maintained close liaison with the Department of State in connection with the proposed UN International Space Conference, particularly in questions of technical content. It is understood that NASA will carry the responsibility for organizing U.S. participation in this Conference. Such participation will come not only from NASA but also from the Department of Defense, universities, and industry.

(*b*) It is expected that NASA will cover the major expenses involved in this Conference, although the Department of State will bear some of them, particularly certain travel and staff expenses. This conforms substantially to the pattern developed in the international conferences on atomic energy.

Question No. 2. According to page 202 of your budget justification book, the fiscal year 1961 estimate contains $1,400,000 for the operation of non-NASA stations in other countries.

(*a*) Are there any other funds that are proposed to be devoted to international activities?

Answer No. 2(*a*). Funds have not generally been segregated for application to international activities by NASA since such international activities are actually extensions of on-going NASA programs. For example, the Scout vehicles, which it is anticipated will be used in support of Canadian and British satellite experiments, have been carried in the budget along with other vehicle costs. A reason for this is that NASA would itself wish to conduct similar experiments if the British and Canadian contributions were not in the picture.

NASA ACTIVELY ENGAGED IN COOPERATIVE INTERNATIONAL SPACE ACTIVITIES

Question No. 3. What are we doing to increase the participation of other nations of the free world in cooperative space activities?

Answer No. 3. NASA is actively engaged in a multifaceted program to increase the participation of other nations in cooperative space activities. For example: (1) In the global tracking network which NASA has organized, about half of the coordinated oversea stations, some two dozen in total, are now or soon will be operated by foreign nationals in whole or in part. Where appropriate and desired, NASA has agreed to make its own stations available for independent scientific activity on the part of foreign scientists, subject to operating requirements. (2) Beyond this, we have made available, in advance, information regarding such experiments as Project Echo in order to permit their independent utilization by foreign scientists to the extent of their interest and capability. (3) We have offered to fly the experiments or complete satellite payloads of foreign scientists in our own rocket vehicles; from this offer have resulted two on-going programs for the launching of Canadian and British satellites. In prospect are several other programs of varying content which may be expected to materialize as the result of current discussions with more than a dozen countries in Europe and the Pacific as well as South America. (4) A senior postdoctoral associateship program, funded by NASA and administered by the National Academy of Sciences, has already brought a half-dozen competent scientists to NASA laboratories. Additional training services are currently under consideration in conjunction with the bilateral discussions just mentioned.

Question No. 4. How many nations have now made formal requests to cooperate with the U.S. in space exploration?

Answer No. 4. Discussions looking toward cooperative space exploration have taken place on either a formal or informal basis with approximately 15 countries, including the Soviet Union. Formal requests, not necessarily transmitted through diplomatic channels, have come from six nations with which cooperative programs are in being or in near prospect, and from several additional countries with which cooperative programs appear likely at some future time.

Question No. 5. As a result of your trip abroad last September, have you received any commitments from the countries you visited relative to joint utilization of facilities in the promotion of space activities?

Answer No. 5. An understanding with respect to joint utilization of facilities and hardware for the promotion of space activities has followed in at least one case from my trip abroad last September. Much of the current activity and discussion referred to earlier, while it has not yet reached this state, has also followed from the same trip.

Senator STENNIS. Mr. Horner?

EXPLANATION OF CURRENT BUDGET REQUEST AND ADMINISTRATIVE DETAILS

Mr. HORNER. Thank you, Mr. Chairman. In the 18 months since the NASA has come into existence, we have had, I think you can see, a large variety of activities, while implementing a current program to carry out our obligations and planning the longer range program over the 10-year period that Dr. Glennan has discussed with you.

We have also been seriously concerned with the marshaling of all of the necessary resources to fulfill these responsibilities.

This is the formulation of the staff, the facilities, the financial support that is necessary, and the organization that is necessary, to carry out these responsibilities.

Dr. Glennan and Dr. Dryden have discussed with you the relative position we are occupying today vis-a-vis the USSR. They have discussed the 10-year plan, and the activities of the year just past. They have also discussed some of the activities that we are carrying on with foreign countries and our schedule of accomplishments during the next year.

Now, for the balance of our presentations, we would like to treat in detail the work that we intend to do with the funds that we are requesting for this budget authorization, and relate them to these resources that we have been busy gathering together, and specifically, of course, to the financial resources and to the organization.

HISTORY OF NASA STAFF GROWTH

I would like to spend just a few minutes and go through the history of our staff growth, as I think it is somewhat unique in the formulation of a new organization in Washington.

As you will recall, the nucleus of our staff came from the 8,040 members of the NACA and their laboratories. This group of people, in effect, were renamed National Aeronautical and Space Administration on October 1, 1958.

A short time later, there were 400 people transferred from the Naval Research Laboratory. This was the Vanguard team.

In the matter of a few months later, the responsibility for the contract operation of the Jet Propulsion Laboratory at Pasadena, Calif., was assigned to NASA. This is a laboratory which is operated by contract with the California Institute of Technology. It brought to us a staff strength which numbers 2,700 today. We expect that staff level to decrease somewhat as work that is currently being done through the Department of Defense is phased out.

But we will expect to have a continuing requirement there for about 2,400 people.

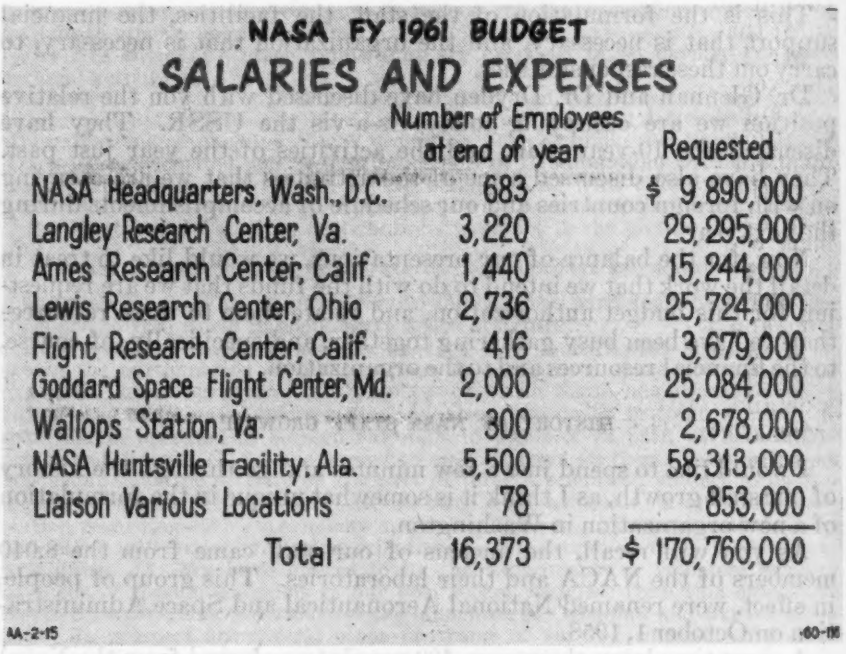
Then in the past few months, about 6 months ago, the decision was announced to transfer the Development Operations Division of the Army Ballistic Missile Agency to NASA. This group, under the

leadership of Dr. Wernher von Braun, comes to us and will be formally brought into existence as the Marshall Space Flight Center, on July 1 of this year. These people have been largely engaged in space activities over the past few years, and bring a real and necessary talent to our ranks.

In addition to these major staff elements that have gone into the creation of NASA, we have had new employees to the extent of creating, at the end of this next fiscal year, a total staff strength of some 16,373 people.

I have on this chart (chart 11, NASA Fiscal Year 1961 Budget, Salaries and Expenses), a summary of the staff strengths in the various laboratories, the resources that are being requested, the financial resources being requested to support those staff strengths.

CHART 11


NASA FY 1961 BUDGET
SALARIES AND EXPENSES
Number of Employees at end of year
Requested
NASA Headquarters, Wash., D.C. 683 $ 9,890,000
Langley Research Center, Va. 3,220 29,295,000
Ames Research Center, Calif. 1,440 15,244,000
Lewis Research Center, Ohio 2,736 25,724,000
Flight Research Center, Calif. 416 3,679,000
Goddard Space Flight Center, Md. 2,000 25,084,000
Wallops Station, Va. 300 2,678,000
NASA Huntsville Facility, Ala. 5,500 58,313,000
Liaison Various Locations 78 853,000
Total 16,373 $ 170,760,000
4A-2-15
60-116

For comparative purposes, I would note that at the end of fiscal year 1960 the staff strength would be about 10,800. The difference is made up over 90 percent by the addition of the Von Braun group.

Senator STENNIS. May I interrupt you there a moment, please. I just want to call your attention to the fact that this committee took your estimates of what you needed for your personnel in acting on your supplemental appropriation request for fiscal year 1960. The House had also approved the full $23 million you requested, but they had language in their report disapproving 75 of the 150 additional positions you had requested for headquarters in Washington, D.C. We are not policemen. We are not watching you over your shoulders. We assume you are responsible people. There is always a temptation in most Government agencies, I think, to take on some more manpower. But I hope that you will have someone really give this attention so as to justify the Congress for being more liberal with you than it has with other, more established, agencies. That is not a lecture; that is a handshake.

Mr. HORNER. I understand, Mr. Chairman. And we do recognize this very serious responsibility that we have.

I might say at this point that we have, in our estimates of appropriations, put detailed backup information supporting the requirement for these numbers.

In the interest of saving time, Mr. Chairman, I would like to suggest that as we go along here, I could identify specific pages from that book which are pertinent to the discussion, and perhaps they might be entered into the record.

Senator STENNIS. I think that is a good suggestion. It is information, and it is a commitment on your part of what you plan to do.

Mr. HORNER. At this particular place, I would like to suggest that pages 9 and 10 in the book be entered in the record. It does provide a detailed breakdown.

Senator STENNIS. All right. Without objection, that matter will be submitted for the record. We will also insert pages 4 and 39.

(The matter referred to is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION SALARIES AND EXPENSES

Program and performance

This appropriation provides for the salaries and operating expenses (other than supplies, equipment, and construction) of the research and development centers and other activities operated by the National Aeronautics and Space Administration with Government personnel.

1. *Aeronautical and space research.*—Research is conducted at the Langley, Ames, Lewis, and Flight Research Centers, located at Langley Air Force Base, Va.; Sunnyvale, Calif.; Cleveland, Ohio; and Edwards Air Force Base, Calif., respectively. The level of operations at these centers will be substantially the same in 1961 as in 1960.

2. *Space flight development and operations.*—The Goddard Space Flight Center at Beltsville, Md., will be the data center for NASA space operations; it will also be responsible for payloads, primarily for Earth satellites, and for directing the manned space flight program. The Wallops Station in Virginia will be utilized for launching sounding rockets, test vehicles, and small satellites. The NASA facility at Huntsville, Ala., will engage in space vehicle development including the Saturn very high thrust booster project. NASA personnel are also located at the Atlantic and Pacific Missile Ranges and worldwide tracking stations. The large increase in 1961 results primarily from the inclusion for the first time in this appropriation of the full amount of salaries and expenses for the Huntsville facility which is being transferred to NASA from the Army. This facility was supported previously by funds for specific missile and space projects, chiefly of the Department of Defense, through the mechanism of work orders placed with the Army industrial fund at the Army Ballistic Missiles Agency. Other increases are required in 1961 for the Goddard Space Flight Center and Wallops Station because of increased workload.

3. *Program direction.*—Increased funding for personnel is required at the NASA headquarters as the size and complexity of the programs continues to grow.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, FISCAL YEAR 1961 ESTIMATES

Summary—salaries and expenses

	Number of employees at end of fiscal year			Appropriations		
	1959 actual	1960 estimated	1961 estimated	1959 actual	1960 actual	1961 requested
NASA Headquarters	428	683	683	$5,538,860	$7,549,300	$9,890,000
Langley Center	3,297	3,220	3,220	30,568,970	27,445,500	29,295,000
Ames Center	1,478	1,440	1,440	16,299,035	14,257,050	15,244,000
Lewis Center	2,783	2,736	2,736	27,215,227	24,840,200	25,724,000
Flight Center	336	416	416	3,154,208	3,038,150	3,679,000
Goddard Center	782	1,214	2,000	2,021,100	11,802,270	25,084,000
Wallops Station	171	225	300	1,356,820	1,700,100	2,678,000
Marshall Center		100	5,500		227,000	58,313,000
Western Office	7	32	46	94,815	338,930	515,500
Atlantic Missile Range Office	4	20	26	20,000	201,500	278,000
Pacific Missile Range Office			6			59,500
Wright Office				17,265		
Total	9,286	10,086	16,373	86,286,300	91,400,000	170,760,000

Summary—salaries and expenses—fiscal year 1961

	NASA Headquarters	Langley Center	Ames Center	Lewis Center	Flight Center	Goddard Center	Wallops Station	Huntsville Facility	Western Office	Atlantic Missile Range Office	Pacific Missile Range Office	Total
Estimated end of year employees	683	3,220	1,440	2,736	416	2,000	300	5,500	46	26	6	16,373
Estimated end of year employment costs	$5,936,774	$22,444,084	$10,518,547	$19,894,614	$2,936,752	$15,711,806	$1,925,284	$40,175,000	$419,605	$236,265	$48,000	$120,246,731
01 All personal services	6,200,000	22,609,000	10,650,000	20,101,000	3,120,000	15,834,000	1,915,000	47,540,000	393,000	226,000	37,000	128,625,000
02 Travel	1,100,000	460,000	160,000	300,000	135,000	2,210,000	150,000	1,281,000	25,000	18,000	10,000	5,849,000
03 Transportation	14,000	12,000	15,000	20,000	3,000	236,000	22,000	100,000	10,000	5,000	5,000	442,000
04 Communications	535,000	82,000	42,000	94,000	20,000	244,000	40,000	229,000	12,000	12,000	4,000	1,314,000
05 Rents and utilities:												
Electric power		2,592,000	2,612,000	2,405,000	14,000	75,000	145,000					7,843,000
Other utilities			125,000	435,000	15,000	25,000						600,000
Rentals	30,000	1,815,000	828,000	853,000	150,000	5,363,000	264,000	6,050,000	46,000			15,399,000
06 Printing	180,000	26,000	15,000	10,000	2,000	25,000	5,000	100,000				363,000
07 Contractual services:												
Life insurance	20,000	74,000	35,000	66,000	10,000	46,000	6,000	132,000	1,700	1,000	500	392,200
Health program	38,000	181,000	81,000	154,000	19,000	101,000	16,000	306,000	2,500	1,500	300	900,300
Security investigations	1,248,000											1,248,000
11 Retirement	384,000	1,441,000	677,000	1,283,000	188,000	919,000	114,000	2,570,000	25,300	14,500	2,700	7,618,500
13 Awards	140,000	1,000	1,000	1,000	1,000	2,000		1,000				147,000
15 Taxes	1,000	2,000	3,000	2,000	2,000	4,000	1,000	4,000				19,000
Total	9,890,000	29,295,000	15,244,000	25,724,000	3,679,000	25,084,000	2,678,000	58,313,000	515,500	278,000	59,500	170,760,000

Estimates of appropriations, salaries and expenses, fiscal year 1961

		Fiscal year 1959 obligated	Fiscal year 1960 estimated	Fiscal year 1961 estimated
01	Personal services:			
	Number of permanent positions (end of year)	9,286	10,086	16,373
	Annual cost of permanent positions (end of year)	$65,142,007	$73,254,506	$120,246,731
	Deduct lapses	6,294,304	3,328,066	2,389,731
	Net cost of permanent positions	[1] 58,847,703	69,926,440	117,857,000
	Intermittent employment	[1] 4,016	67,900	250,000
	Regular pay above 52-week base	[1] 246,121	558,710	463,000
	Overtime and night-work differential	[1] 776,388	1,530,300	9,538,000
	Other allowances	[2] 15,574	33,000	67,000
	Reimbursable details	27,311	164,450	450,000
	Total personal services	[1] 59,917,113	72,280,800	128,625,000
02	Travel	[1] 1,285,911	2,866,400	5,849,000
03	Transportation of things:			
	Household goods	[1] 103,991	191,000	442,000
	All other	[1] 279,887	[2] 1,485,000	[2] 3,993,000
04	Communication services:			
	Leased lines	60,313	[2] 156,500	[2] 336,000
	All other	391,556	883,600	1,314,000
05	Rents and utility services:			
	Electric power	6,191,226	6,494,800	7,843,000
	Other utilities	398,367	469,000	600,000
	Rentals	1,541,553	2,585,000	15,399,000
06	Printing and reproduction	160,466	203,000	363,000
07	Other contractual services:			
	Research contracts	816,510		
	Repairs and alterations	[1] 1,221,710	[2] 2,012,100	[2] 5,060,000
	Miscellaneous services	[1] 947,020	[2] 1,522,400	[2] 7,403,000
	Services by other Government agencies	[1] 20,421,095	[2] 2,556,000	[2] 5,079,000
	Security investigations	178,595	500,000	1,248,000
	Federal life insurance	[1] 185,440	214,000	392,200
	Federal health program			900,300
8	Supplies and materials	[1] 6,927,053	[2] 8,636,000	[2] 17,607,000
9	Equipment	[1] 3,632,845	[2] 6,316,000	[2] 11,867,000
11	Grants, subsidies, and contributions	[1] 3,785,722	4,566,300	7,618,500
13	Refunds, awards, and indemnities	3,202	134,000	147,000
15	Taxes and assessments	[1] 10,868	12,100	19,000
	Total	108,460,443	114,084,000	222,105,000
	Partially or fully funded under "Research and development"	−22,472,147	−22,684,000	−51,345,000
	Unobligated balance	298,004		
	Total allotment	86,286,300	91,400,000	170,760,000

[1] Partially funded under "Research and development."
[2] Fully funded under "Research and development."

Mr. HORNER. Now, with the assignment of the Huntsville group, and the responsibility for superbooster developments, we were caused to take a very serious look at our organizational structure in our need for organization modification.

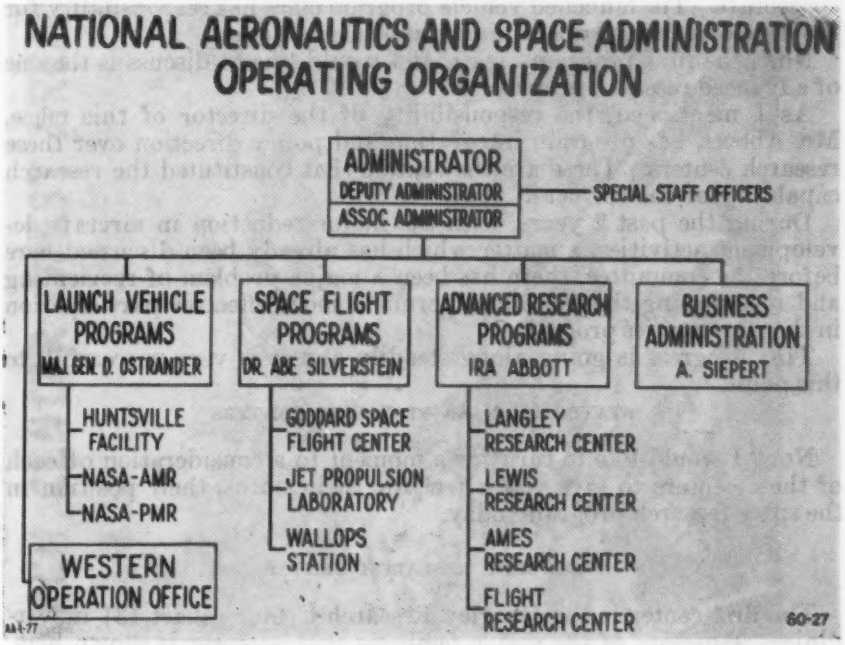
Certainly, one of the most serious problems that we saw was the need for improving the reliability of vehicles, reducing the numbers of different types of vehicles, in carrying out the development programs in our weightlifting capability as rapidly and as expertly as possible.

To do this, we decided to reorganize our effort, build an organization on a functional basis, and a functional staff and field organization that we have arrived at we show on this chart.

NASA OPERATING ORGANIZATION

Because of succeeding presentations all being keyed to this chart, I think I will put it over here and leave it exposed, Mr. Chairman, because the additional directors who are going to talk to the committee all have significant responsibilities in this (chart 12, NASA Operating Organization).

CHART 12



Mr. LEHRER. Where does the Office of Life Sciences fit in?

Mr. HORNER. I was about to mention the fact that as of 2 weeks ago we announced the formulation of a fourth functional director in our organization. We have, as yet, only appointed a director to this new functional division. We do not have any further buildup of staff in that area. Therefore, we have not included it on the chart, and we have not scheduled a specific presentation of any life sciences program, because it does not show as such in our program.

I feel sure that in another year there will be significant accomplishments and significant plans for accomplishment which will be of interest to the committee and will be included as part of any such presentation.

The other functional areas—in addition to this special staff, officers which are attendant to any organization management—are included here. The Office of Business Administration includes those business matters that you would expect. In the actual research and development program, these three staff officers have functional responsibilities.

The advanced research program office is responsible for the management of the inhouse research center activity. The space flight program office has responsibility for development and operation of spacecraft. The launched vehicle program office has responsibility for the development and operation of launched vehicles.

Now, the first program area that I would like to discuss is the one of advanced research program.

As I mentioned, the responsibility of the director of this office, Mr. Abbott, has program integration and policy direction over these research centers. These are the centers that constituted the research capability of the former NACA.

During the past 2 years, with the major reduction in aircraft development activities, a matter which has already been discussed here before the committee, there has been a major problem of reorienting and reequipping the centers to permit a more effective participation in the astronautics program.

This progress is going along steadily and it is very successful, to this point.

STATUS OF NASA RESEARCH CENTERS

Now, I would like to turn for a moment to a consideration of each of these centers to give you a feel for their status, their position in the space research program today.

LANGLEY RESEARCH CENTER

The first center is the Langley Research Center (chart 13) in Virginia. A picture of the major facilities at this center is shown here. In addition to the facilities as you see them here, the current budget has a request for an additional $11 million to provide two new laboratories.

CHART 13

CHART 13

This is the hypersonic aerothermal research laboratory, a facility which will provide a capability to test vehicles on the ground at temperatures and at gas pressures and velocities that will be experienced by any vehicle reentering the atmosphere, say from a trip to the Moon. This is a facility that is very sorely needed. It is an area in which we anticipate very considerable research problems.

The other laboratory that is being requested for Langley, at the cost of $4 million, is a dynamics research facility to permit the testing of vehicles under conditions of vibration and the environmental conditions of space.

The laboratory has a total staff of some 3,220 people. That staff level has been held for the past 3 years. It has been a process of rehiring skills that are not currently available, and retraining people who are now in the program into skills that will be more useful in the space program.

The total facility investment at this laboratory at the present time is $154 million.

At this point, Mr. Chairman, if pages 41 and 309–321 could be put into the record, they give specific backup to these facility requirements.

Senator STENNIS. Without objection, it will be so ordered.

(The material referred to is as follows:)

LANGLEY RESEARCH CENTER

ESTIMATES OF APPROPRIATIONS - SALARIES AND EXPENSES - FISCAL YEAR 1961

	F.Y. 1959 Obligated	F.Y. 1960 Estimated	F.Y. 1961 Estimated
01 PERSONAL SERVICES:			
Number of permanent positions (end of year)	3,297	3,220	3,220
Annual cost of permanent positions (end of year)	$22,209,951	$22,329,084	$22,444,084
Deduct lapses	308,964	211,984	149,084
Net cost of permanent positions	21,900,987	22,117,100	22,295,000
Intermittent employment	---	---	---
Regular pay above 52-week base	84,099	168,000	86,500
Overtime and night-work differential	197,791	196,000	226,000
Other allowances	520	1,100	1,500
Reimbursable details	---	---	---
TOTAL PERSONAL SERVICES	22,183,397	22,482,200	22,609,000
02 TRAVEL	238,457	403,800	460,000
03 TRANSPORTATION OF THINGS:			
Household goods	29,534	8,000	12,000
All other	81,922	117,400*	120,000*
04 COMMUNICATION SERVICES:			
Leased lines	---	8,500*	10,000*
All other	51,009	70,000	82,000
05 RENTS AND UTILITY SERVICES:			
Electric power	1,880,782	2,032,000	2,592,000
Other utilities	---	---	---
Rentals	828,361	939,000	1,815,000
06 PRINTING AND REPRODUCTION	18,103	25,000	26,000
07 OTHER CONTRACTUAL SERVICES:			
Research contracts	---	---	---
Repairs and alterations	597,699#	565,200*	958,000*
Miscellaneous services	230,136#	228,000*	246,000*
Services by other Government agencies	82,997	82,000*	138,000*
Security investigations	---	---	---
Federal life insurance	72,342	66,850	74,000
Federal health program	---	---	181,000
08 SUPPLIES AND MATERIALS	2,562,086#	3,224,500*	5,610,000*
09 EQUIPMENT	768,028#	1,037,000*	2,018,000*
11 GRANTS, SUBSIDIES, AND CONTRIBUTIONS	1,420,251	1,416,150	1,441,000
13 REFUNDS, AWARDS, AND INDEMNITIES	55	1,000	1,000
15 TAXES AND ASSESSMENTS	1,106	1,500	2,000
TOTAL	31,046,225	32,708,100	38,395,000
Partially (#) or fully funded (*) under "Research & Development"	-518,403	-5,262,600	-9,100,000
Unobligated balance	41,148	---	---
TOTAL ALLOTMENT	$30,568,970	$27,445,500	$29,295,000

LANGLEY RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

HYPERSONIC AEROTHERMAL DYNAMICS FACILITY

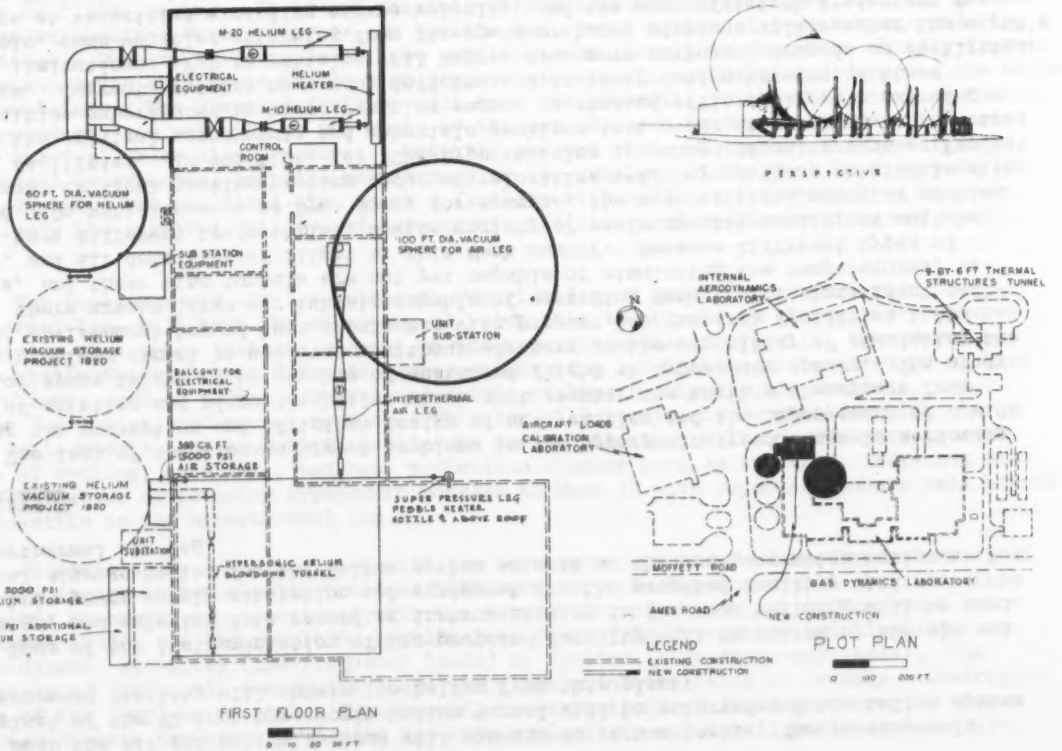
1. DESCRIPTION:

This project proposes the construction of a facility for simulating vehicle environment in the hypersonic speed ranges. As indicated in the drawing on the following page the facility will consist of two main systems, one using air and the other using helium. The air system will be located in the west wing of the gas dynamics laboratory, and the helium system will be located in an extension to the west wing.

The system using helium as the test medium is required primarily for aeroelastic studies. This system will have two legs with test sections approximately 4 feet in diameter, one providing test speeds up to Mach 10 and the other to Mach 20; each leg will be capable of heated operation up to 650° F. Running times will be of the order of 20 seconds.

The other system will employ air and will be used primarily for the study of aerothermal problems. The air for this system will be stored at 15,000 psi; this pressure will be obtained by a topping compressor that will draw on an existing 1,800-psi air supply. This system will also have two legs. One leg (the hyperthermal leg) will employ continuous-arch heating from a 10,000-kw d-c current to generate temperatures in the 7,000° R to 16,000° R temperature range. Interchangeable throats and liners for the water-cooled conical nozzle will be used to produce simulated velocities, altitudes, and temperatures in the Mach 12 to 20 flight regime. Running times up to 3 or 4 minutes are expected. The temperature and pressure potential of this leg will open the way to even higher velocities as the state of the art advances in arc generation at high pressures. The other leg of the air system (the superpressure leg) will consist of a superpressure zirconia pebble heater capable of supplying 4,500° R air at pressures up to 15,000 psi. Running times of about 20 seconds are expected for this leg.

HYPERSONIC AEROTHERMAL DYNAMICS FACILITY



Both the air and helium systems will exhaust to vacuum tanks. The closed-cycle helium plant of the 20-inch hypersonic helium tunnel will be enlarged and the helium system of the proposed facility will obtain its helium from this plant.

Some of the instrumentation of the proposed facility will be shared by the air and helium legs, and existing data recording instrumentation in the same building will be used. The electric power supply substation and equipment for the proposed facility will serve the electrical storage heater for the helium system as well as the arc-generation equipment for the hyperthermal air leg.

2. JUSTIFICATION:

The lack of solution to urgent problems in the hypersonic speed range is seriously retarding the conception and efficient design of new vehicles and the improvement of a wide variety of existing and planned vehicles which must reenter the earth's atmosphere from orbital or space flight or be capable of sustained flight at hypersonic speeds. The study of these problems cannot be undertaken without advances in the capability of simulating the vehicles' environment beyond that obtainable with present-day research facilities. At present, there are no large air tunnels capable of exceeding Mach 12 for significant testing times, and these wind tunnels are not yet capable of simulating the temperatures, velocities, and air densities of flight at this Mach number. Because different types of vehicles have different trajectories, a wide variety of environmental conditions must be simulated. On vehicles such as Dyna Soar, for example, the most critical maneuver problem and the most critical heating problem occur at velocities well beyond those obtainable with existing facilities. In addition, for ICBM-type vehicles or manned capsules such as Project Mercury, the critical aerodynamic and materials problems that occur at the high temperatures and velocities experienced by these vehicles cannot be studied efficiently with existing facilities. Current vehicles have many deficiencies in their design because of these facility limitations. Future vehicles will impose even more stringent demands on facilities. For example, some vehicles returning from far-space or lunar missions will reenter the earth's atmosphere at velocities exceeding escape velocity, and the most efficient trajectory for returning freighter vehicles from space could produce air temperatures near the vehicle that would be greater than those for a near-earth ballistic missile.

The hyperthermal air leg of the proposed facility will, by use of continuous-arc

The hyperthermal air leg of the proposed facility will, by use of continuous-arc heating, be able to produce the very high temperatures of hypersonic flight and will open the way for large increases in the Mach number, velocity, and temperature capability of air wind tunnels. The tunnel will be able to duplicate the velocities and temperatures in the Mach 20 flight regime. It is not possible to simulate these conditions with any method depending on chemical fuels, whereas arc heating has almost unlimited temperature-producing capabilities. The growth potential of the continuous-arc tunnel is therefore chiefly limited by the engineering ability to handle high-temperature air without melting or eroding the walls of its container. The proposed facility will have the potential to increase its Mach number, air temperature, and velocity as the state of the art advances in throat survival and arc-chamber survival under high pressures. With the present state of the art in these fields, the proposed hyperthermal leg will permit many of the problems of the Mach 20 flight regime to be undertaken for the first time using a facility with sufficient testing time to study conclusively the survival ability and aerodynamic efficiency of reentry vehicles of many types.

The superpressure air leg, although restricted to a lower temperature than the hyperthermal leg, will have the advantage of being able to operate at stagnation pressures much greater than those that can be used in the hyperthermal leg. It will, therefore, be able to obtain the high unit Reynolds number and heating rates that are required to explore many problems, such as throat survival and nozzle cooling for hypersonic ram jets, super-pressure facilities, and rocket nozzles. This leg will permit, in conjunction with the use of small models, the economical testing to destruction that will be necessary in some studies of cooling, materials, and heat protection schemes such as ablation. This leg also has the potential of powering hypersonic nozzles to Mach 17 with Reynolds numbers well beyond those possible in the hyperthermal leg.

In addition to and associated with the aerothermal problems of the hypersonic speed regime are important aeroelastic problems that have not been experimentally studied. The aeroelastic phenomena are associated with the interaction of structural deformations and aerodynamic loads, and the resulting problems may range from divergence (static loads) through dynamic stability (low-frequency loads) to flutter (high-frequency loads). The consequence of inadequate design for these aeroelastic instabilities is usually catastrophic failure of the complete mission. Experimental investigations of these phenomena at hypersonic Mach numbers are urgently needed for both preliminary and detail design and require

the consideration of a wide range of configurations, materials, methods of construction, and flight envelopes. No adequate facility exists at the present time for the study of the aeroelastic problems in the Mach number dynamic pressure range which includes that encountered by hypersonic airplanes, reentry vehicles, and the antimissile missiles. It is not possible within the present state of the art to construct air tunnels that can provide the range and magnitude of dynamic pressure and Mach number necessary to explore these effects.

As a testing medium, the aeroelasticity leg will use helium which provides several distinct practical advantages for aeroelastic studies. First, the time scale of aeroelastic phenomena of concern does not allow appreciable direct coupling of thermal effects with aeroelastic forces. Hence, it is possible to separate heating effects from aeroelastic phenomena, and this may be done in a wind tunnel at hypersonic speeds using helium as a test medium. This is possible because heat is not required to avoid liquefaction of helium until Mach numbers well in excess of 20 are reached. Tests may be run without heat, and a nominal amount of heat may be added to isolate certain thermal effects on aeroelastic phenomena. The aeroelastic models can thus be greatly simplified (less expensive), and the usual model construction techniques which have proven so successful in the past may be directly applicable.

Secondly, a high dynamic pressure is needed for aeroelastic studies. Conventional tunnels designed for aerodynamic studies do not have this capability. By using helium, a much higher dynamic pressure is obtainable as compared to air for given stagnation pressures. For the proposed tunnel, the dynamic pressure at Mach 10 will approach 7,000 pounds per square foot and for Mach 20 would be nearly 1,000 pounds per square foot. The pilot model hypersonic aeroelasticity tunnel now operating at Mach 7 has proven the adequacy of helium as a test medium; however, it is far too small for most aeroelastic studies (inclusion of pressure cells, for example).

Adequate study of both the aeroelastic and aerothermal problems requires a usable test core of at least 2 feet. Because of the thick boundary layers at the Mach numbers to be encountered in the hyperthermal and hypersonic dynamics legs of this facility, test sections of the order of 4 feet in diameter are required. For this size test section, a closed-cycle helium system, which permits the helium to be purified and reused, is required for economic reasons in the hypersonic dynamics leg. The helium plant of the present 20-inch hypersonic tunnel will be enlarged, and this plant will operate the Mach 10 and Mach 20 helium legs of the facility and, in addition, will eliminate the severe restrictions on running time and on

The frequency of runs now imposed on the 20-inch hypersonic tunnel. In addition, the combining and sharing of various features and supporting equipment of the air and helium systems of the proposed facility will eliminate considerable duplication of new equipment and will permit maximum use of existing equipment and instrumentation.

3. **COST ESTIMATE:**

Helium heating system and pebble heater		$434,000
Helium heating system	$311,000	
Pebble heater and ceramics	123,000	
Electrical equipment and power system		1,236,000
Outdoor switchgear primary cable and substation construction	75,200	
10,000-KW industrial ignitron rectifier	663,500	
Regulating equipment	71,400	
Resistor	95,700	
Secondary cable and control	127,600	
Arc starting equipment	76,500	
Auxiliary unit substation	58,600	
Starter group assemblies and auxiliary controls and wiring	67,500	
Equipment foundations and housing, building and utility revisions and additions		479,000
Alterations to existing building and utilities	138,000	
Building addition and mechanical hoisting equipment	201,000	
Equipment foundations	140,000	
Settling chambers, arc chamber and test section		1,615,000
Settling chambers and arc chamber	230,000	
Nozzles and test section	657,400	
Model support systems	575,100	
Mechanical parts of Schlieren systems and second minimum	152,500	

Pressure, vacuum, helium, and air piping		$613,000
Water cooling system and aftercooler		329,000
Air, helium, and vacuum storage		963,000
15,000 psi air storage	$120,000	
5,000 psi helium storage	145,000	
100-foot diameter sphere for air leg	573,000	
60-foot diameter sphere for helium leg	125,000	
Controls		311,000
Multistage vacuum pumping and air dryer for the air system		675,000
Additional helium purification equipment and modifications to existing system		382,000
Instrumentation		700,000
Data recording equipment	$175,000	
Force measuring instrumentation	143,000	
Pressure measuring instrumentation	120,000	
Temperature measuring instrumentation	40,000	
Optical instrumentation	40,000	
Recording and read-out equipment	103,000	
Programmer and test parameter instrumentation	79,000	
Design and engineering services		220,000
Total estimated cost		$7,957,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	36 months

LANGLEY RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

DYNAMICS RESEARCH LABORATORY

1. DESCRIPTION:

This project provides for the construction and instrumentation of a research laboratory designed to study dynamics problems of high performance aircraft, missiles, space vehicles, space stations, and satellite packages in simulated density, temperature, acceleration, and vibration environments. A drawing of the proposed facility is shown on the following page. The laboratory will provide the capability for study of both the structural dynamics of the vehicles and their components, and the free-body dynamics with respect to space orientation control, guidance, and navigation. Configurations envisioned include erectable space structures and parallel boost configurations as well as the more conventional configurations. The following items are proposed for construction and installation under this project:

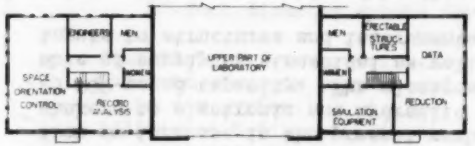
(a) A modernization of the vibration facilities of the Langley Center including the addition of required shakers ranging from an increase in the present number of 50-pound capacity shakers to electronic and hydraulic vibration systems up to 25,000-pound capacity. The electronic systems will be capable of supplying sinusoidal as well as complex random force inputs to structures and instrumentation packages.

(b) A large backstop capable of handling dynamic models of space stations, space vehicles, and boost configurations; components of full-scale space stations, vehicles, and boost systems; and satellite packages and vehicle instrumentation packages.

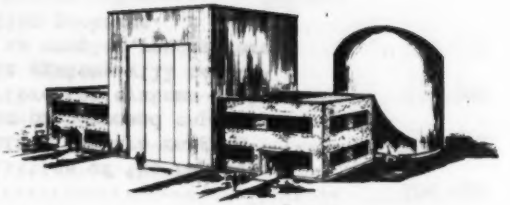
(c) An environmental heat and hard vacuum chamber capable of simulating atmospheric density and heat conditions of hyper-

LANGLEY RESEARCH CENTER
FISCAL YEAR 1961 ESTIMATES

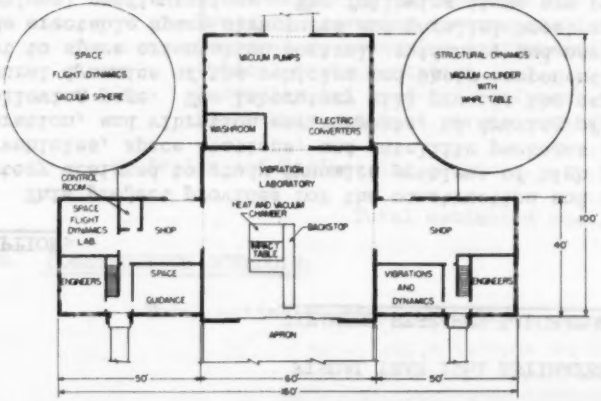
DYNAMICS RESEARCH LABORATORY



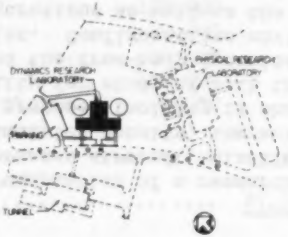
SECOND FLOOR PLAN



PERSPECTIVE



FIRST FLOOR PLAN
0 5 10 20 Ft.



LOCATION PLAN
0 50 100 FT.

LEGEND
EXISTING CONSTRUCTION
NEW CONSTRUCTION

sonic flight while simultaneously conducting vibration,

sonic flight while simultaneously conducting vibration, acceleration, and fatigue research on vehicle structural and instrumentation components and control systems.

(d) A whirl table capable of providing large acceleration fields simultaneously while simulating other vibrational and flight environments.

(e) Simulation equipment to provide means for the study of gain and phase effects in semimechanical and analog studies of structural servo feedback induced vibrations and instabilities, and for the control and programming of environmental test conditions; provisions are included for a tie-in to existing computing facilities at the Langley Center.

(f) A shock and impact loading table to simulate and study effects of shock loads arising from conditions such as boost ignition and burnout, stage separation and landing impact.

(g) Apparatus for simulating electromagnetic field and other environmental effects on the spin stabilization of space vehicles and packages; apparatus to provide free suspension of space orientation control and guidance systems and stabilized vehicles; and apparatus to provide suitable radiation simulation of celestial space reference bodies.

(h) A vacuum sphere 60 feet in diameter for the study of space orientation control, guidance, and navigation.

(i) A vacuum cylinder 60 feet in diameter and 60 feet high with provisions for the installation of the whirl table and with provisions for studying the behavior of large space vehicle components at high altitudes, including the behavior of erectable structures.

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(j) A building for offices, shops, setup and control of tests, computing and data reduction equipment, and support machinery.

(k) The necessary vacuum pumps to complement the equipment presently available at the Langley Center and to permit pump down of either the vacuum sphere or the cylinder to a moderate vacuum in approximately 2 hours.

2. JUSTIFICATION:

The development of satellites in the United States has been greatly hampered by lack of adequate facilities for research information on problems in dynamics and hence has proceeded on a cut and try, ad hoc test basis. The dynamic characteristics of vehicles are basic ingredients in the analysis of design for efficient performance and structural integrity. Lack of information on the dynamic characteristics has contributed to failures. Many of these have been caused by broken and malfunctioning equipment due to large repeated loads which lead to high vibratory response and fatigue of vehicle elements. The motions of the fuel and the vibratory deformations of the vehicle, coupling with the control system, as well as unbalance of the spinning payloads have also caused loss of vehicles. The future ferry-reentry vehicles, space stations, and vehicles for landing on the moon will generate many dynamics problems which must be solved.

Loss or malfunction of vehicles could be avoided and a more efficient structure could be obtained by appropriate applied research and by more comprehensive proof testing of the vehicle components and payloads under conditions which more nearly simulate the combined environments which the vehicles will experience. The laboratory under this project is designed primarily to provide simulated environments, from launch to orbit to landing, for research to obtain the structural efficiency and integrety demanded for high performance and to insure the reliable operation of the vehicle.

The present Langley vibration laboratory was planned nearly 20 years ago and was equipped to vibrate propeller blades and aircraft flutter models. Although some modernization has been made and new equipment added, the present facilities are totally inadequate for vibration research on space vehicles. The proposed facility will provide a larger laboratory, equipped with more versatile equipment of greater capacity designed primarily to do research

on, and supplement analyses of, vibration, shock, and other dynamics problems. In order

on, and supplement analyses of, vibration, shock, and other dynamics problems. In order to minimize cost and cope with the size and complexity of existing and planned vehicles, research will be carried out by means of dynamic models, full-scale tests of components, and by the use of simulators.

The proposed laboratory will provide the unique facilities required to handle many dynamics problems on a variety of configurations and systems. The equipment will provide, for example, the research capability necessary to:

(a) Spin and vibrate space stations and models up to 50 feet in diameter in vacuum to determine stresses, loads, leakage, and other factors essential to improve the structural integrity of the vehicle.

(b) Study the performance of various types of stabilization and guidance systems over long periods of time of the order of several months.

(c) Study the dynamics and loads problems of rendezvous of two vehicles while in vacuum, including the transfer of occupants.

(d) Vibrate dynamic models of large multistage vehicles in order to obtain the vibration modes and to study problems of structural feedback and servo systems.

(e) Study separately, and in combination, the effects of noise, vibration, acceleration, heat, vacuum, etc., on space and reentry vehicles.

3. COST ESTIMATE:

Building	$519,000
Utilities and paving	65,000
Backstop and foundation	550,000
Impact and shock table	30,000

Cranes		$49,500
Vacuum system		723,500
Environment test cell		112,500
Centrifuge		104,500
Electrical systems		530,000
Instrumentation		1,200,000
Vibration test system	$350,000	
Weights, balances and accessories for backstop	75,000	
Orientation and stabilization equipment	300,000	
Radiation simulation system	100,000	
Simulation computer system	75,000	
Data recording and readout equipment	100,000	
Auxiliary laboratory instrumentation	200,000	
Shop equipment and furniture		22,000
Design and engineering services		94,000
Total estimated cost		$4,000,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	24 months

LEWIS RESEARCH CENTER

Mr. HORNER. The next Center which I would like to discuss briefly is the Lewis Research Center (chart 14) with a total staff strength of 2,736 people, a total facility investment today of $148 million. We are suggesting in this budget an additional investment of $9 million for two laboratories, an energy conversion laboratory to carry out research for conversion of energy from heat sources into electrical energy.

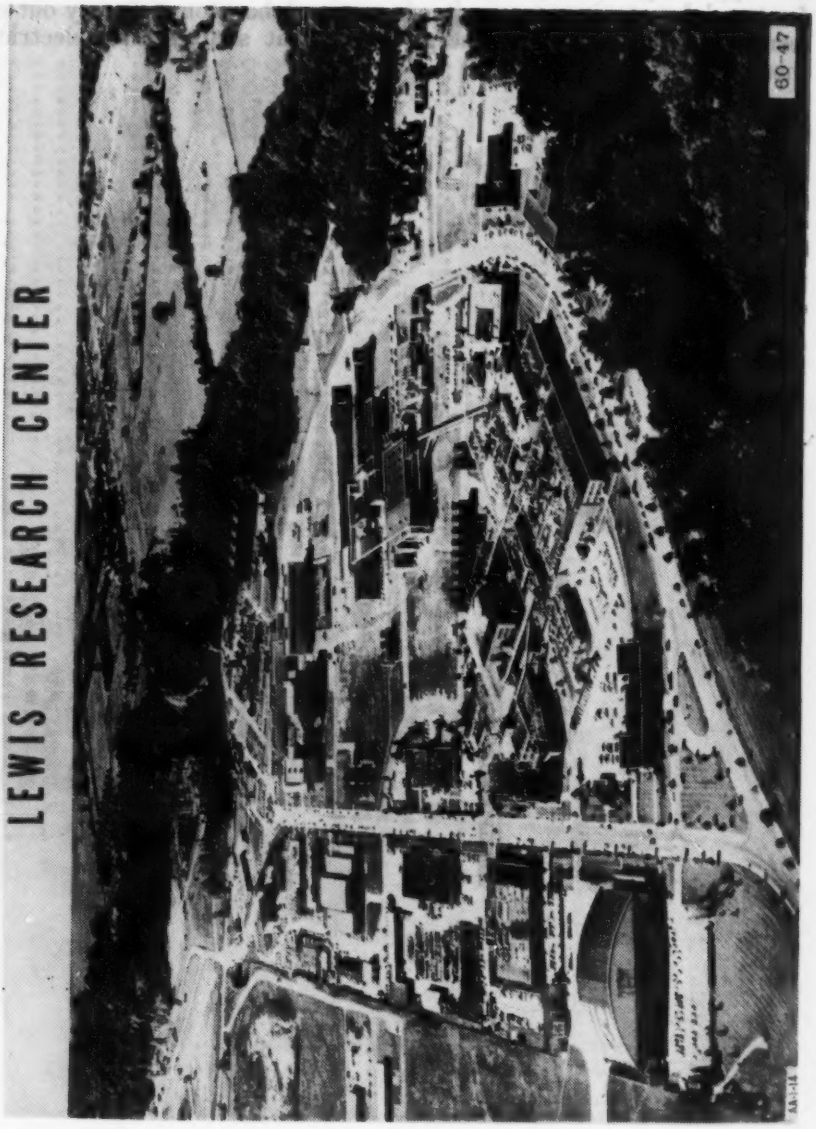


CHART 14

As we go on in the program discussion here, you will note that that is a very important area of our research work, and this facility is badly needed in support of that work.

There is an additional laboratory, then, for materials research. This Center's area of work is primarily involved in investigation for propulsion and auxiliary power. These two functions are most demanding of new materials, and new materials research to be carried out at this Center will be greatly aided and abetted by the new laboratory we are proposing.

As a matter of fact, much of the research that is proposed cannot be carried out without the new laboratory.

For support of this facility requirement, I would like to suggest that pages 43 and 325 through 334 be added to the record.

Senator STENNIS. All right. Without objection, it will be so ordered.

(The material referred to is as follows:)

LEWIS RESEARCH CENTER

ESTIMATES OF APPROPRIATIONS - SALARIES AND EXPENSES - FISCAL YEAR 1961

	F.Y. 1959 Obligated	F.Y. 1960 Estimated	F.Y. 1961 Estimated
01 PERSONAL SERVICES:			
Number of permanent positions (end of year)	2,783	2,736	2,736
Annual cost of permanent positions (end of year)	$19,606,568	$19,799,614	$19,894,614
Deduct lapses	434,278	+76,076	86,614
Net cost of permanent positions	19,172,290	19,875,690	19,808,000
Intermittent employment	---	---	---
Regular pay above 52-week base	74,555	152,310	76,500
Overtime and night-work differential	155,409	153,500	210,000
Other allowances	5,890	6,000	6,500
Reimbursable details	---	---	---
TOTAL PERSONAL SERVICES	19,408,144	20,187,500	20,101,000
02 TRAVEL	130,516	180,000	300,000
03 TRANSPORTATION OF THINGS:			
Household goods	16,959	15,000	20,000
All other	94,796	173,000*	300,000*
04 COMMUNICATION SERVICES:			
Leased lines	574	3,000*	6,000*
All other	70,465	75,000	94,000
05 RENTS AND UTILITY SERVICES:			
Electric power	2,014,946	2,073,800	2,405,000
Other utilities	316,560	368,000	435,000
Rentals	276,925	603,000	853,000
06 PRINTING AND REPRODUCTION	5,198	4,000	10,000
07 OTHER CONTRACTUAL SERVICES:			
Research contracts	---	---	---
Repairs and alterations	300,759	528,000*	669,000*
Miscellaneous services	219,735	467,000*	700,000*
Services by other Government agencies	3,336	5,000*	5,000*
Security investigations	---	---	---
Federal life insurance	57,372	59,700	66,000
Federal health program	---	---	154,000
08 SUPPLIES AND MATERIALS	2,181,761#	2,800,000*	4,000,000*
09 EQUIPMENT	1,019,887	2,280,000*	3,500,000*
11 GRANTS, SUBSIDIES, AND CONTRIBUTIONS	1,236,204	1,271,200	1,283,000
13 REFUNDS, AWARDS, AND INDEMNITIES	845	1,000	1,000
15 TAXES AND ASSESSMENTS	1,657	2,000	2,000
TOTAL	27,356,639	31,096,200	34,904,000
Partially (#) or fully funded (*) under "Research & Development"	-187,656	-6,256,000	-9,180,000
Unobligated balance	46,244	---	---
TOTAL ALLOTMENT	$27,215,227	$24,840,200	$25,724,000

LEWIS RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

LEWIS RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

ENERGY CONVERSION LABORATORY

1. DESCRIPTION:

This project proposes the construction of an integrated complex of facilities for a broad research program on energy conversion and power generation processes and equipment. Major components of the facility comprise highly specialized equipment and instrumentation, suitable laboratory spaces for the equipment, control rooms and required services, as follows:

Radiant energy conversion facilities: Equipment to produce a variety of radiant energy sources, including electromagnetic waves, and neutron beams of various energies; and equipment for preparing special cells, and related devices.

Thermal energy conversion facilities: Equipment to provide thermal energy sources, and instrumentation and apparatus for testing and evaluating systems.

Chemical properties equipment: Advanced instrumentation for ascertaining properties of matter in its various states in support of energy conversion research as well as other researches at the laboratory pertaining to propulsion and space research.

Liquid metal pump facility: A test facility for pump research including cycle heater, condenser, research pump, prime mover, flow control instrumentation and liquid metal storage and purification equipment.

Liquid metal turbine facility: A closed-loop turbine rig including boiler, research turbine, condenser, service pump, power absorber, controls and instrumentation.

Systems dynamics and cavitation facility: A small scale closed-loop rig including pump, heat exchanger, lines and ducting, test sections, supply tank and special devices for studying fundamental dynamics and cavitation characteristics of liquid metals.

Liquid metal heat transfer facility: A multi-closed loop heat transfer rig involving fluid supply tank, pumps, test section, heat source, purging and cleaning equipment and instrumentation for studying convectors, nucleate boiling, condensation and evaporation phenomena of liquid metals at temperatures from 1,000° to 2,500° F.

Friction and lubrication apparatus: A friction test rig and vacuum chambers for investigation of bearings and seals for liquid metal applications.

A drawing of the proposed energy conversion laboratory is presented on the following page.

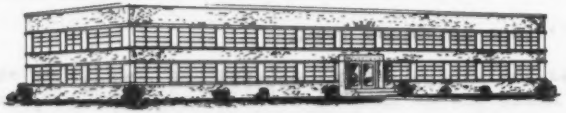
2. JUSTIFICATION:

A prime requirement for effective space flight and space exploration is light-weight, efficient electrical production devices. Not only is the need for light weight and high efficiency very great, but the power requirements for future space vehicles vary over extremely wide ranges of duration, average power, and peak power. To adequately meet these requirements, a broad research program on a wide variety of energy conversion processes is essential. Such a program must encompass exploratory, basic research on various concepts of direct conversion processes, applied research on turbo-electric system components, research into the heat transfer and thermodynamic and hydrodynamic characteristics of novel working fluids.

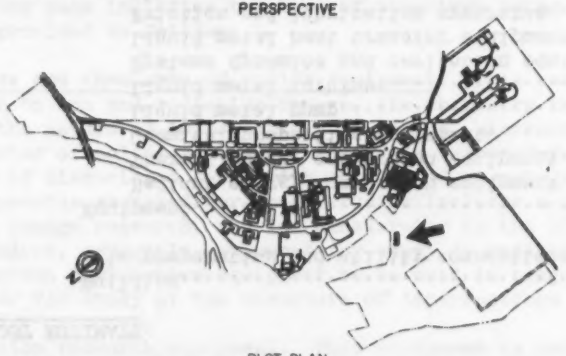
Exploratory research on direct conversion processes includes the production of electrical energy from heat and radiation of various kinds. Typical concepts requiring experimental investigation are photovoltaic cells of various kinds, photogalvanic cells, microwave amplifiers, thermopiles, plasma diodes, and utilization of energy gaps in semi-conductors or artificial metals. Such direct conversion methods offer the promise of improved reliability for long term space missions through the elimination of rotating machinery. The theoretical efficiencies are comparable to those of conventional electric power generation equipment. The direct conversion devices also hold promise for improved lifetime against meteoroid penetrations of the power plant waste heat radiator.

To achieve light-weight, turbo electric systems requires vaporized and liquefied metals at high temperatures as the working fluid. There are therefore introduced a host of new problems relating to the unusual hydrodynamic and thermodynamic properties of these fluids

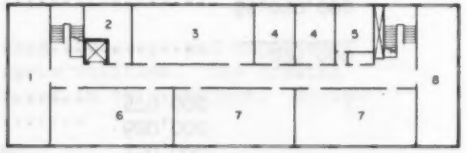
ENERGY CONVERSION LABORATORY



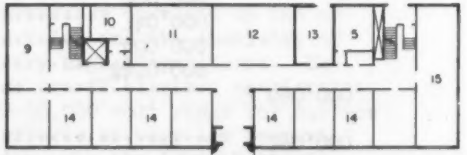
PERSPECTIVE



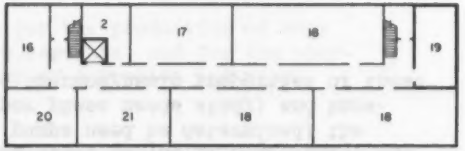
PLOT PLAN



SECOND FLOOR PLAN



FIRST FLOOR PLAN



BASEMENT PLAN

0 25' 50'
SCALE

1. ELECTRIC GENERATOR, MICROWAVE GENERATORS AND RECEIVERS
2. STOCK ROOM
3. MASS SPECTROSCOPY
4. SPECTROSCOPIC LABORATORY
5. MENS ROOM
6. IMAGE FURNACE, HEATERS, VACUUM EQUIPMENT
7. VACUUM FURNACE
8. GAS CHROMATOGRAPHY
9. CONFERENCE ROOM
10. WOMENS ROOM
11. CHEMISTRY LABORATORY
12. MICROSCOPES
13. CHEMICAL PROPERTIES LABORATORY
14. OFFICES
15. SPECTROMETER, LIGHT SOURCES
16. X-RAY DIFFRACTION CAMERA
17. SHOP AREA
18. EQUIPMENT ROOM
19. PROTON BEAM SOURCE, X-RAY EQUIP., MONOCHROMATORS
20. MEASURING EQUIPMENT, HALL COEFF., THERMOELECTRIC POWER
21. ELECTRON GUN, ULTRAVIOLET LIGHT, SUN SOURCE

as well as to the design and operation of such high-temperature components as pumps, turbines, evaporators, and heat exchangers. To rapidly and effectively develop this new technology will require a well coordinated research program on all these problems. Pumps must be capable of operating with these fluids near their boiling point; turbines must operate with high efficiency and with considerable moisture in the working fluid; the cavitation phenomena of liquid metals in valves and pumps need be determined; the mechanism of the flashing of the liquid into the vapor phase needs study; and knowledge of the general heat transfer, hydrodynamic and thermodynamic properties of these liquids and their vapors is virtually non-existant.

3. COST ESTIMATE:

Building		$785,000
Site preparation and utility connections		190,000
Equipment		3,850,000
Radiant energy conversion equipment	$450,000	
Thermal energy conversion equipment	480,000	
Chemical properties equipment	340,000	
Liquid metal pump	390,000	
Liquid metal turbine	840,000	
Systems dynamics and cavitation equipment	160,000	
Liquid metal heat transfer equipment	620,000	
Friction and lubrication apparatus	570,000	
Design and engineering services		225,000
Total estimated cost		$5,050,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	27 months

LEWIS RESEARCH CENTER

FISCAL YEAR 1962 ESTIMATES

LEWIS RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

BASIC MATERIALS RESEARCH LABORATORY

1. DESCRIPTION:

A basic materials research laboratory is required to extend the scope and magnitude of the materials research capabilities of NASA to the field of space vehicles. The drawing on the following page indicates the type of structure being proposed in this project. Equipment will be provided as follows:

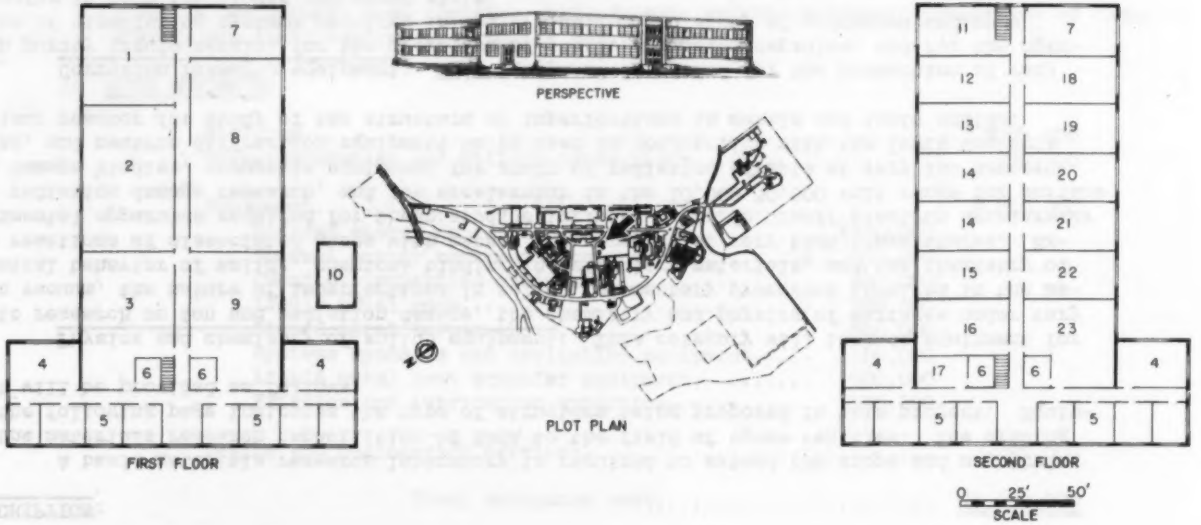
Physics and chemistry of solids equipment: This category will include equipment for basic research on ion and radiation damage, the chemistry and physics of surfaces under very high vacuum, the nature of imperfections in solids, elementary processes involved in the mechanical behavior of solids, chemical binding in refractory materials, and the chemistry of the reactions of dissociated gases with metals and ceramics at very high temperatures. Experimental apparatus required for these studies includes a Van de Graaff electron accelerator for radiation damage research, and ion accelerator in the 10,000-50,000 volt range for surface ion damage studies, cryogenic equipment for study of radiation effects at very low temperatures, and neutron diffraction equipment to be used in conjunction with the Lewis Center's nuclear reactor for study of the structure of imperfections in metals and ionic solids.

Corrosion research equipment: This equipment is needed for the production of very high purity liquid metals, for the operation of static corrosion capsules, and for the operation of circulating systems required in the evaluation and study of corrosion and mass transfer in both the liquid and vapor state.

Composite materials equipment: It is proposed to provide mechanical processing equipment to prepare and process fibers and whiskers, and to permit the fabrication of metallic fibers. The equipment will include swagers, wire drawing benches, melting and blowing apparatus, gas jet torches, seeding and spinning equipment, a powder rolling mill capable of producing sheet, a large capacity rolling mill, and equipment for such advance forming techniques as deforming at very high pressures,

LEWIS RESEARCH CENTER
FISCAL YEAR 1961 ESTIMATES

BASIC MATERIALS RESEARCH LABORATORY



1. WELDING, BRAZING AND JOINING
2. ULTRA-PURE MATERIALS
3. COMPOSITE MATERIALS
4. OFFICE
5. OFFICES
6. WASHROOM
7. RADIATION DAMAGE
8. CORROSION RESEARCH
9. HIGH TEMPERATURE, HIGH PRESSURE
10. CRYOGENIC TANK RESEARCH
11. ELECTRON DIFFRACTION
12. HIGH TEMPERATURE CHEMISTRY
13. SURFACE CHEMISTRY
14. SPACE ENVIRONMENT
15. LIQUID METALS
16. SPECIMEN PREPARATION
17. DARK ROOM AND GLASS BLOWING
18. OXIDATION
19. METAL PHYSICS
20. DIFFUSION STUDIES
21. NUCLEAR MAGNETIC RESONANCE
22. MECHANICAL PROPERTIES
23. DUCTILE CERAMICS

explosive forming, and production of composite structures. Whisker growing equipment will include chemical tanks, vapor deposition apparatus, high pressure tanks, electro-

explosive forming, and production of composite structures. Whisker growing equipment will include chemical tanks, vapor deposition apparatus, high pressure tanks, electro-deposition tanks, and very high vacuum chambers.

Ultra-pure materials equipment: Melting equipment capable of operation at very high temperatures and vacuum, vapor deposition equipment, and equipment for chemically processing and purifying refractory metals and ceramics will be provided.

Welding, brazing, and joining equipment: Investigations in this field will require facilities for vacuum and hydrogen brazing, fluxing facilities, heat treating baths, and furnaces. Welding equipment of all types, automatic welders for seam welding, hydrogen arc pressure welding, as well as ultrasonic and electron beam welders, will be provided for studying the properties of metals, semi-conductors and insulators. Electrical and thermal conductivity characteristics will be evaluated. The variation of these properties with such parameters as temperature, composition and structure would also be studied. The equipment required will include devices for the preparation of high purity materials such as high vacuum zone refining equipment, processing equipment, furnaces, molding machines, and testing equipment for making precise electrical measurements.

High pressure-high temperature equipment: This category will include a hydraulic press capable of producing pressures in excess of one million pounds per square inch, associated with a resistance heater power supply for obtaining high temperatures, Bridgeman apparatus, and apparatus for determining crystallographic properties of materials.

Cryogenic tank research equipment: Equipment will be provided for conducting research on minimum weight propellant tankage for booster and space propulsion systems using cryogenic propellants such as liquid hydrogen, liquid oxygen, and liquid fluorine. Also required will be equipment for photoelastic studies, tankage insulation studies, and studies of shock absorption devices for landing vehicles.

2. JUSTIFICATION:

To meet expanding NASA research responsibilities it is mandatory that the scope and magnitude of the NASA materials research effort be substantially expanded, primarily to study the unique and entirely new materials problems that are encountered in space vehicles.

The materials problems in space vehicles arise from three sources. First, the vehicle itself operates in a novel (and in some respects still unkown) environment. Second, novel propulsion systems are being devised and many of these subject materials to severly corrosive environments. Third, there is a need for weight reduction in order to eliminate the penalty of high propellant usage in bringing unnecessary weight in space.

A basic materials research laboratory is proposed to conduct research on these problems, as follows:

Physics and chemistry of solids research: Basic research in the physics and chemistry of solids is needed to gain an understanding of the behavior of materials under space environment conditions in order that their limitations will be known and in order that new or improved materials can be developed.

Corrosion research: One method which has been proposed for the generation of electricity for electric propulsion and auxiliary power devices is through the use of a turbo-generator system in which the turbine is driven by the vapors of the alkali metals (sodium, rubidium, lithium, etc.). These vapors are then recirculated after being condensed in a radiator. Such a system would offer considerable weight saving over the use of a straight gaseous heat transfer medium. The alkali metals are known to be very corrosive at mild temperatures. At temperatures near and above their boiling point this corrosion can be anticipated to be much more severe.

Composite materials research: Wires, when they are drawn to very fine sizes, exhibit unusual strength relative to more massive forms of the same materials. By incorporating very strong wires, fibers or filaments with relatively weak matrix materials, it should be possible to make unusually strong, or strong and light weight structures. A common material known to have a strength of almost 2 million pounds per square inch is iron, but only when it is in whisker form. By combining very strong metallic and ceramic whiskers, in relatively weak matrix materials, it may be possible to obtain significantly stronger materials for use in an infinite number of propulsion systems applications. New and radically different composites are needed for future outer air and space vehicles. The development of useful combinations and configurations will require basic materials research and the development and evaluation of the finished items.

Ultra-pure materials research: A high temperature and vacuum apparatus along with extremely precise analytical facilities to prepare and analyze ultra-high purity metals and

Ultra-pure materials research: A high temperature and vacuum apparatus along with extremely precise analytical facilities to prepare and analyze ultra-high purity metals and ceramics is required to realize the potential of the most refractory materials. The properties of many refractory metals and ceramics are ill-defined because of their varying composition and purity. In other cases, the known properties reflect undesirable characteristics which may be due to impurities. Tungsten, the most refractory metal, for example, has been considered for many advanced propulsive devices but it apparently lacks the ductility required to enable it to be fabricated. This lack of ductility may be associated with trace amounts (on the order of a few parts per million) of interstitial gases such as oxygen, nitrogen, and hydrogen. It has been hypothesised that many ceramics may show improvements in ductility and toughness if both their composition and purity could be controlled.

Welding, brazing, and joining research: The joining of ultra-thin laminates of different materials with varying physical properties (i.e., coefficient of linear expansion), poses a difficult problem. Joining of dissimilar materials such as metal-plastics and metal-ceramic combinations provides another major research area. As research with the more refractory metals brings them into more common usage, methods for joining these metals to themselves and to each other must be studied. Cold joining of materials by ultrasonic welding affords promise as a means of preventing weld damage of adjacent metal areas. This is an entirely new area of research with extensive potential applications to propulsion systems.

High pressure-high temperature research: It is possible that many metals and ceramics systems unobtainable by conventional melting or powder techniques could be synthesized by high pressure metallurgy. Significant improvements in hardness, strength, fatigue creep, and ductility properties of metals, ceramics, and cermet materials may be obtainable.

Cryogenic tank research: For rocket boosters and space propulsion systems, the propellant tankage makes up a sizable portion of the vehicle structure. Because of the high cost of putting extra weight in orbit or in transporting the weight to other planets, every means possible must be evaluated to determine minimum weight tankage for the propellants of interest for nuclear and chemical rockets. Information available on material properties and construction techniques applicable to hydrogen and fluorine tankage is extremely meager so, consequently, added research is required. Another area of research is that of determining optimum construction practices in discontinuity regions, i.e., regions of welding and joining.

53795 O—60—pt. 1——9

3. COST ESTIMATE:

Building		$1,050,000
Utility connections		50,000
Equipment		2,895,000
Crane	$50,000	
Equipment for study of physics and chemistry of solids	600,000	
Corrosion research equipment	200,000	
Composite materials equipment	495,000	
Ultra-pure materials equipment	250,000	
Welding, brazing, and joining equipment	300,000	
High-pressure, high temperature equipment	500,000	
Equipment for cryogenic tank research	500,000	
Design and engineering services		55,000
Total estimated cost		$4,050,000

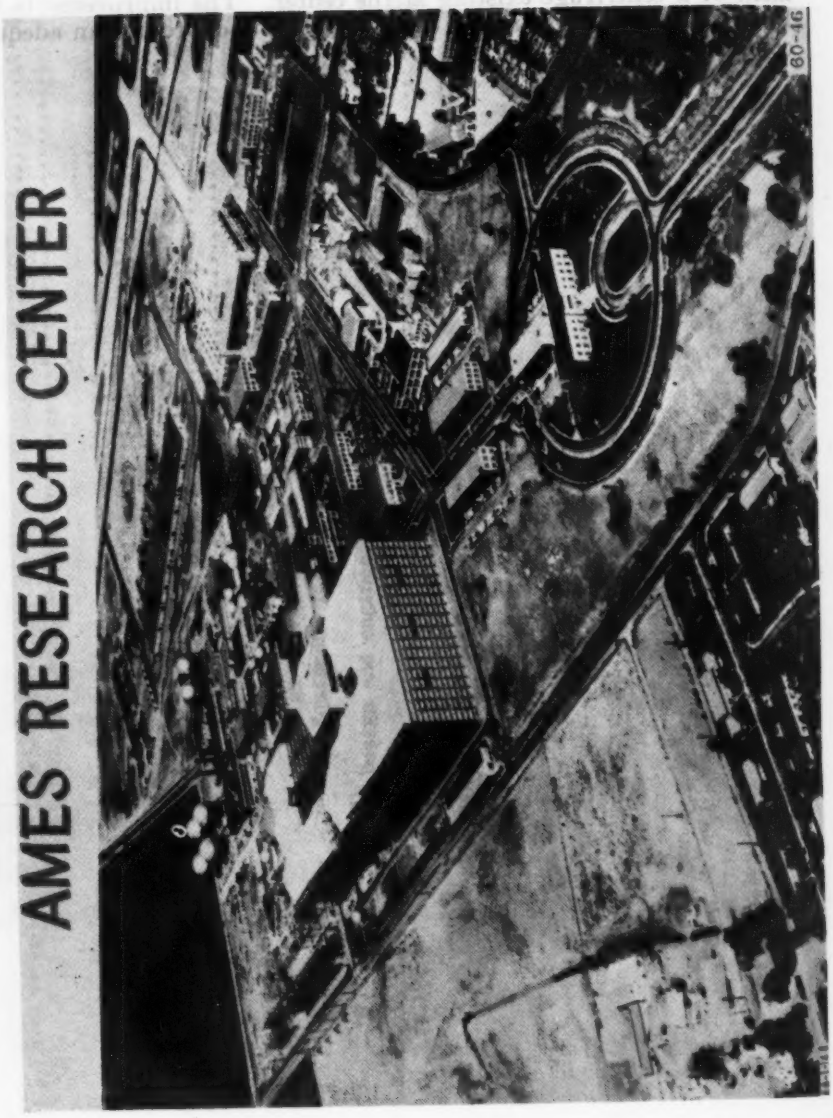
4. CONSTRUCTION SCHEDULE:

Total estimated completion time	15 months

AMES RESEARCH CENTER

Mr. HORNER. The next center I would like to discuss is the Ames Research Center (chart 15), located near Palo Alto, Calif. It has a total facility investment today of $107 million, staffed with 1,440 people. We are requesting in this budget an additional $980,000 for improvement of a centrifuge existing at the center. The improvements will be in the control system for the centrifuge and provide an adequate computer capability.

CHART 15



The center is engaged primarily in automatic control and stabilization. We also have several active projects at this center in full scale testing of vertical and short take-off and landing aircraft.

Senator STENNIS. When was the construction of this center started?

Mr. HORNER. Dr. Dryden will be able to answer that question better than I.

Dr. DRYDEN. 1940.

Senator STENNIS. Give us the date on these others.

Mr. HORNER. Langley Center is the original center of the NACA, which goes back 43 years.

Dr. DRYDEN. Construction of the Langley Research Center started in 1917, of the Ames Research Center in 1939, and of the Lewis Research Center in 1940.

Senator STENNIS. All right.

Mr. HORNER. For support of this facility requirement and staff, at this center, I would like to suggest that pages 42 and 322 through 324 be added to the record.

Senator STENNIS. Without objection, those pages will be added.

(The material referred to is as follows:)

AMES RESEARCH CENTER

ESTIMATES OF APPROPRIATIONS - SALARIES AND EXPENSES - FISCAL YEAR 1961

	F.Y. 1959 Obligated	F.Y. 1960 Estimated	F.Y. 1961 Estimated
01 PERSONAL SERVICES:			
Number of permanent positions (end of year)	1,478	1,440	1,440
Annual cost of permanent positions (end of year)	$10,374,891	$10,458,547	$10,518,547
Deduct lapses	265,178	68,697	52,547
Net cost of permanent positions	10,109,713	10,389,850	10,466,000
Intermittent employment	---	---	---
Regular pay above 52-week base	39,186	78,900	40,600
Overtime and night-work differential	86,393	80,000	142,000
Other allowances	1,151	1,000	1,400
Reimbursable details	---	16,450	---
TOTAL PERSONAL SERVICES	10,236,443	10,566,200	10,650,000
02 TRAVEL	99,485	110,000	160,000
03 TRANSPORTATION OF THINGS:			
Household goods	9,005	10,000	15,000
All other	26,929	40,000*	45,000*
04 COMMUNICATION SERVICES:			
Leased lines	---	---	---
All other	32,573	35,000	42,000
05 RENTS AND UTILITY SERVICES:			
Electric power	2,238,271	2,268,000	2,612,000
Other utilities	73,853	90,000	125,000
Rentals	339,402	470,000	828,000
06 PRINTING AND REPRODUCTION	14,221	7,000	15,000
07 OTHER CONTRACTUAL SERVICES:			
Research contracts	---	---	---
Repairs and alterations	160,832	508,500*	766,000*
Miscellaneous services	124,306	240,500*	252,000*
Services by other Government agencies	8,165	18,000*	107,000*
Security investigations	---	---	---
Federal life insurance	32,021	31,000	35,000
Federal health program	---	---	81,000
08 SUPPLIES AND MATERIALS	1,177,031	1,500,000*	1,500,000*
09 EQUIPMENT	1,024,215	1,330,000*	1,400,000*
11 GRANTS, SUBSIDIES, AND CONTRIBUTIONS	644,968	665,850	677,000
13 REFUNDS, AWARDS, AND INDEMNITIES	711	1,000	1,000
15 TAXES AND ASSESSMENTS	3,434	3,000	3,000
TOTAL	16,245,865	17,894,050	19,314,000
Partially (#) or fully funded (*) under "Research & Development"	---	-3,637,000	-4,070,000
Unobligated balance	53,170	---	---
TOTAL ALLOTMENT	$16,299,035	$14,257,050	$15,244,000

AMES RESEARCH CENTER

FISCAL YEAR 1961 ESTIMATES

CENTRIFUGE EQUIPMENT

1. DESCRIPTION:

The Ames 30-foot centrifuge is a minimum facility using surplus electrical drive equipment of marginal performance. It uses approximately two-thirds of the capacity of the existing analog computer and lacks separate supporting instrumentation. In order to make the centrifuge capable of independent operation, improve its performance to the design maximum, and equip it with instruments for adequate pilot display and safety of operation, the following items are required:

(a) Electronic control equipment consisting of two analog computer consoles providing 200 d.c. amplifiers, 10 coordinate resolvers, 20 servo multipliers, 20 electrical multipliers, 20 diode function generators, recorders, plotters and special mechanical resolvers.

(b) Electrical drive equipment to replace temporary surplus electrical drives; the five motors involved power the three gimbal drives on the cab, the centrifuge arm rotation, and the drive for vertical translation of the cab.

(c) Instrument equipment consisting of specialized instrumentation which must duplicate aircraft instruments in appearance yet be driven by the outputs from analog and digital computers.

2. JUSTIFICATION:

Electronic control equipment: Experience with the pitch-roll chair has shown that the analog computer element of the control system is one of the basic factors influencing the utilization of a simulator. Even the simplest problems that can be run on the centrifuge require about two-thirds of the Ames Center's existing computer capacity, resulting in severe interference with the other uses of the computer.

In addition, the complexity of the computer setup and the fact that it is involved in the safety of the operation make it essential that an independent computer setup be available at all times for the simulator.

Electrical drive equipment: The use of surplus electrical drives has resulted in a performance decrement of 20-30 percent from that required on the basis of analog computer studies. This has an adverse effect on research requiring the simulation of rocket-boosted take-off and trajectories and high-speed aileron rolls on conventional aircraft. The installation of new drive equipment will permit the facility to meet its design requirements.

Instrument equipment: Simulator instrumentation is always plagued by the problem of keeping up with ever-changing aircraft cockpit appearance. To provide the proper display for the pilot without having to start over again for each simulation it is necessary to provide a flexible system of standard servo outputs and followers driving movements whose dials and entire external appearance can be modified radically and relatively easily. The items proposed in this project will furnish the basic hardware for such a system. In general, the actual instruments cannot be used because on the simulator they must be driven by the analog computer rather than by physical inputs, such as motion or air pressure.

3. COST ESTIMATE:

Computer equipment		$390,000
Electrical drive equipment		435,000
Three gimbal drives	$127,000	
Vertical and spin drives	308,000	
Instrument equipment		155,000
Specialized instruments	35,000	
Displays and oscilloscopes	10,000	
Advanced control system mockups	25,000	
Instrument positioning equipment	25,000	
Transducers, transmission, and recording equipment	60,000	
Total estimated cost		$980,000

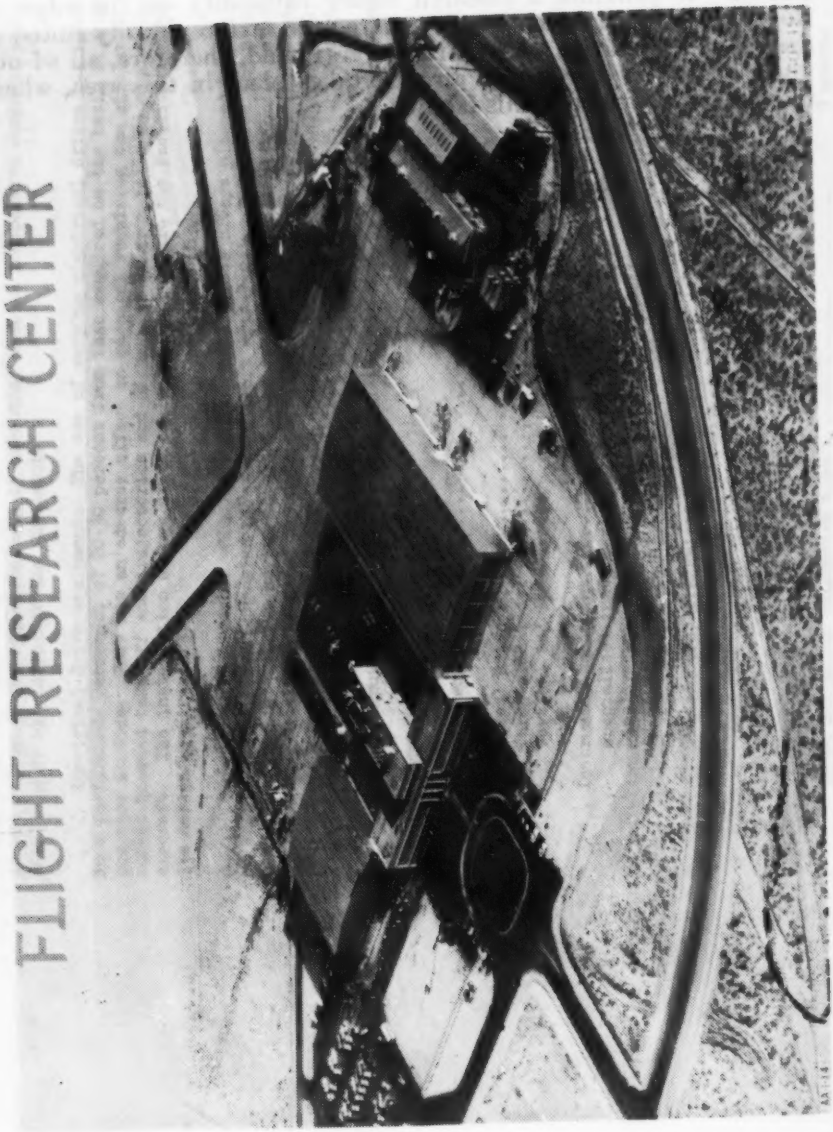
4. CONSTRUCTION SCHEDULE:

Total estimated completion time	8 months

FLIGHT RESEARCH CENTER

Mr. HORNER. The fourth and last center that I would like to discuss in connection with this particular area of our program, we turn to the Flight Research Center (chart 16). This is a unique facility in the Nation. It provides a research center capability on the edge of Rogers Dry Lake, which is a 75-square-mile surface, ideally suited to the ground operation of research aircraft and, therefore, all of our flight operation of research aircraft takes place in this area, where they can be recovered at this facility.

CHART 16



Senator MARTIN. Where is that located?

Mr. HORNER. It is at Edwards, Calif. It is on the edge of Rogers Dry Lake, in the Mojave Desert.

We have a total staff at this facility of 416 people. We have a facility investment of about $5 million. We have in this current budget no new requirement stated for facilities.

The major program activity at this center at the moment is a flight testing of the X–15. Several flights in this airplane have been made by the contractor's test pilot thus far, exploratory flight, to determine the functional integrity of the airplane. Only last week, an NASA pilot completed his first flight in preparation for the flight research program on this particular airplane.

The next year should certainly be a very meaningful year on this project.

For support of the staffing requirements at this particular center, I would like to suggest that page 44 be added to the record (chart 17, Flight Research Center).

Senator STENNIS. Without objection, it is so ordered.

(The material referred to is as follows:)

CHART 17

FLIGHT RESEARCH CENTER

ESTIMATES OF APPROPRIATIONS - SALARIES AND EXPENSES - FISCAL YEAR 1961

	F.Y. 1959 Obligated	F.Y. 1960 Estimated	F.Y. 1961 Estimated
01 PERSONAL SERVICES:			
Number of permanent positions (end of year)	336	416	416
Annual cost of permanent positions (end of year)	$2,316,670	$2,921,952	$2,936,752
Deduct lapses	228,443	439,952	17,752
Net cost of permanent positions	2,088,227	2,482,000	2,919,000
Intermittent employment	---	---	---
Regular pay above 52-week base	8,784	22,400	11,300
Overtime and night-work differential	64,638	125,000	139,600
Other allowances	92	100	100
Reimbursable details	---	28,000	50,000
TOTAL PERSONAL SERVICES	2,161,741	2,657,500	3,120,000
02 TRAVEL	71,389	90,000	135,000
03 TRANSPORTATION OF THINGS:			
Household goods	903	7,000	3,000
All other	8,806	16,600*	9,000*
04 COMMUNICATION SERVICES:			
Leased lines	52,036	108,000*	108,000*
All other	10,277	15,000	20,000
05 RENTS AND UTILITY SERVICES:			
Electric power	7,152	8,000	14,000
Other utilities	7,954	9,000	15,000
Rentals	66,459	76,000	150,000
06 PRINTING AND REPRODUCTION	1,203	2,000	2,000
07 OTHER CONTRACTUAL SERVICES:			
Research contracts	---	---	---
Repairs and alterations	94,493	92,500*	60,000*
Miscellaneous services	33,036#	40,000*	85,000*
Services by other Government agencies	861	2,500*	4,000*
Security investigations	---	---	---
Federal life insurance	6,138	7,450	10,000
Federal health program	---	---	19,000
08 SUPPLIES AND MATERIALS	299,866#	250,000*	400,000*
09 EQUIPMENT	202,792#	324,000*	384,000*
11 GRANTS, SUBSIDIES, AND CONTRIBUTIONS	129,084	163,200	188,000
13 REFUNDS, AWARDS, AND INDEMNITIES	85	1,000	1,000
15 TAXES AND ASSESSMENTS	1,438	2,000	2,000
TOTAL	3,155,713	3,871,750	4,729,000
Partially (#) or fully funded (*) under "Research & Development"	-21,562	-833,600	-1,050,000
Unobligated balance	20,057	---	---
TOTAL ALLOTMENT	$3,154,208	$3,038,150	$3,679,000

Mr. HORNER. Now, these four centers for program integration and policy guidance purposes report to the Director of the Advanced Research programs, Mr. Abbott. If the committee agrees, at this hour, Mr. Abbott will spend a few minutes covering in detail the actual research programs that are undertaken at the centers.

Senator STENNIS. All right, gentlemen, we shall now hear Mr. Abbott.

STATEMENT OF IRA H. ABBOTT, DIRECTOR OF ADVANCED RESEARCH PROGRAMS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Senator STENNIS. Are you director in charge of these programs?

Mr. ABBOTT. Yes, sir, Mr. Chairman, I am Director of Advanced Research Programs, and, as such, I am responsible for the research programs at the research centers which were just described for you by Mr. Horner.

DESCRIPTION OF NASA'S ADVANCED RESEARCH

I would now like to tell you something about this advanced research which produces the technological information that will be needed for the development of the advanced vehicles of the future.

We use the term "advance research," to indicate, first, the conduct of objective research to produce the technological background that will be needed for future exploration and use of space with both manned and unmanned vehicles, and also for aeronautical and missile activities. Secondly, the use of these research findings to generate new flight concepts in both space and aeronautics. Finally, the provision of research assistance to assure the prompt and effective application of our research results by the NASA and also by the military services and other Government agencies.

This research, as Mr. Horner said, is conducted in the research centers which he described, and also through research grants and contracts by unviersities and other research organizations.

At the persent time, most of this activity is devoted to a broad program of research which is directly related to NASA's space mission. However, we are continuing, I believe, to fulfill our responsibility to conduct research to support and guide our Nation's aeronautical and missile activities.

The amount of this aeronautical research has decreased considerably in recent years, however, to the point where it is now constituting about 25 percent of our total effort, as was stated earlier this afternoon.

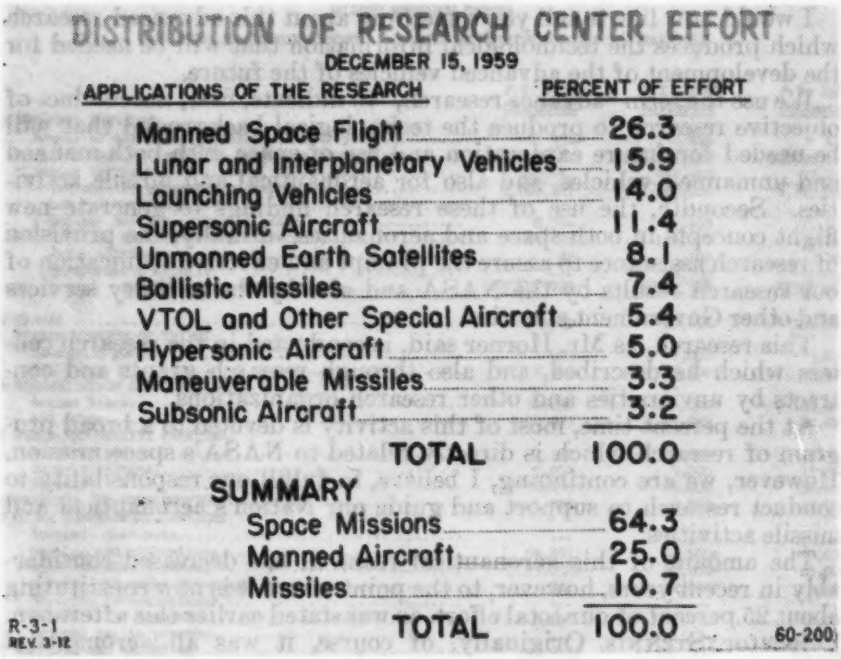
Senator STENNIS. Originally, of course, it was all aeronautical research.

Mr. ABBOTT. Yes, sir. This reduction is, I believe, consistent with and reflects the changing emphasis, particularly in military programs, from aeronautical activities to missile and other types of activities.

I believe it also is consistent with the growing capability of industry and other Government agencies to perform certain types of aeronautical research for which the country previously looked almost exclusively to NASA.

The breakdown of our current research effort (chart 18, Distribution of Research Center Effort) is shown on this chart. This chart is strictly applicable to December 15, 1959, but it reflects very well the current activity.

CHART 18



I would like to call your attention to the fact that almost two-thirds of our efforts are devoted to research related to space missions, 25 percent to manned aircraft, and about 11 percent to missiles.

Now, a great deal of judgment is needed to assign applications to this research. Particularly, in the more fundamental areas, it is almost impossible to tell exactly where the research is going to be applicable. Consequently, more than 64 percent of our research is applicable to space, and certainly much more than 25 percent of it is applicable to manned aircraft. But the chart represents the distribution according to primary justifications for the research projects.

I think it is worth pointing out that over 25 percent of our effort is on manned space flight. This effort is not only supporting Project Mercury, in a rather intensive manner at all our research centers, but is also doing research which will be needed to permit the development of following programs.

We notice the next larger areas are lunar and interplanetary vehicles and launching vehicles. You will notice 11 percent is for supersonic aircraft. Nearly half of this 11 percent is on direct support of current and projected military projects, such as the B–70, and the rest of it is on general research to create new ideas for forthcoming military vehicles, and also to support the large economical transport of the future, which I foresee will fly in the general neighborhood of 2,000 miles an hour.

One other area that is probably worth mentioning is the VTOL and other special aircraft, where we are supporting activities on the types of aircraft badly needed for certain Army missions, and which

also probably will have special utility for short haul commercial transports.

Now, there is another way of looking at our distribution of research effort which, from the research man's point of view, is probably a more valid method, and that is to break it down into research areas. This next chart represents our programing for the fiscal year 1961, in accordance with the budget which you have before you. (See p. 560, chart 66, Fiscal Year 1961 Estimates.)

You will notice that the largest single effort will be on hypersonic aerodynamics. This represents the very large effort which will be needed to solve the problems of atmospheric reentry for satellites, lunar mission vehicles, and other space vehicles.

There is also some activity here relating to very advanced aircraft, such as the X–15, for instance.

Essentially, the statements I just made apply both to hypersonic aerodynamics and flight mechanics the next item which has to do with control and guidance.

The reason for the large effort in chemical rockets research is obvious, I think. The large effort in the materials and structures research reflects directly the high temperatures, materials, and structures problems, which are associated with large rockets and also with the atmospheric reentry problem for spacecraft.

A fair amount of this effort is also in support of materials and structural research for space vehicles in the space environment.

The areas at the bottom of this chart, where the efforts are small, are either one of two things; they either represent areas in which we are just getting started, such as power generation research for spacecraft, or they represent areas in which we are rapidly phasing out, where the research is essentially completed, such as jet engine research.

STATUS OF POWER GENERATING RESEARCH

Senator STENNIS. I thought you were already pretty far down the road on this power generation research.

Mr. ABBOTT. We have not made very much headway in getting our research started in this area.

Dr. DRYDEN. Perhaps you should explain that.

Mr. ABBOTT. Yes. This power generation has to do with providing power in the space vehicle to power the radio transmitters and other instruments, in the first case, and finally, to provide the large amounts of power that will be required in the future for such things as electrical propulsion.

Now, at the present time we are really not in a bad situation as regards our immediate vehicles, where we are using batteries and solar power. But as the vehicles become larger and very much larger amounts of power will be required, we will have to go to other methods.

Senator STENNIS. Go to a new plateau.

Mr. ABBOTT. Yes, and certainly one of the very enticing methods for solution of this problem will be nuclear energy, which involves the machinery that will be required to convert the nuclear energy to electrical power.

I used the term "objective research" at the outset. I think this vehicle spectrum chart (chart 19, Vehicle Spectrum) will give you a little better idea of what I mean by that term.

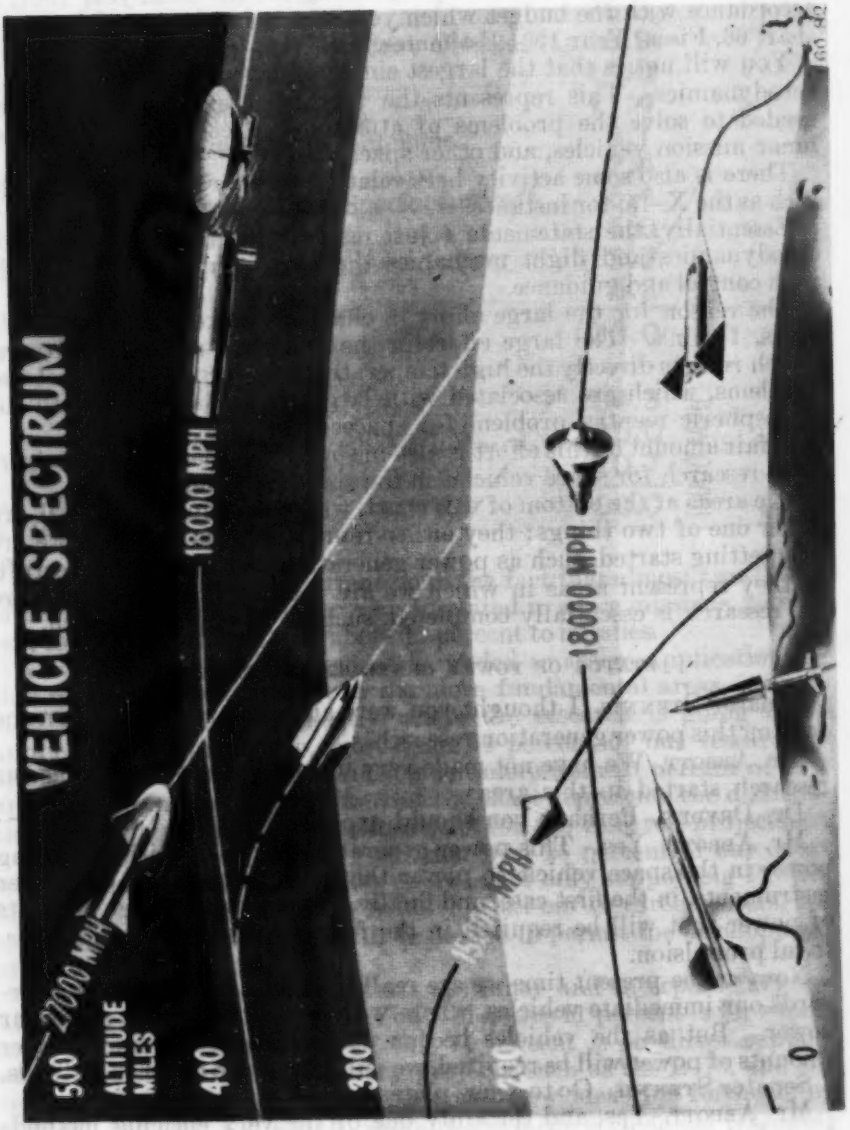

VEHICLE SPECTRUM
ALTITUDE MILES
500
400
300
18000 MPH
18000 MPH
0

CHART 19

We do not design or develop vehicles at our research centers. Our job is to identify the research problems of vehicles of the future and to do the research that will be necessary to permit good engineering solutions to these problems.

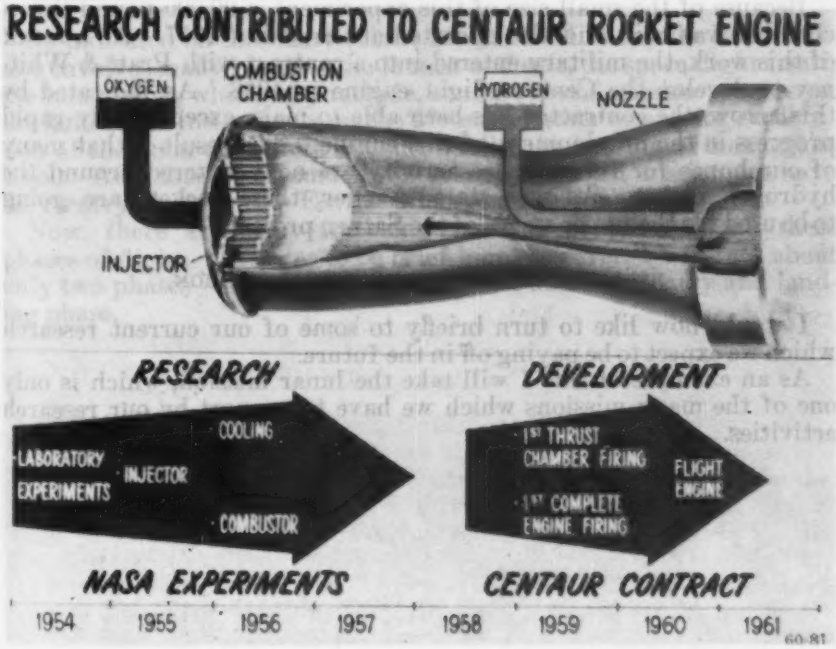
This was the nature of our effort in connection with the X–15 airplane between about 1952 and 1955. It was also the nature of our activity with regard to the blunt ballistic missile nose cone and the concepts for Project Mercury. This research was largely done between 1953 and 1958. During this period we also worked on the concept which led to the Dynasoar project.

These other vehicles represent possible applications in the future of research which is going on today. They include such things as space stations, manned satellites, taxi-type vehicles to go both to and from space stations, and possible manned lunar vehicles.

RESEARCH ON LIQUID HYDROGEN

I would like to turn now to one example of research which we did in the past, which is currently finding application in our space program. I would like to refer specifically to the liquid hydrogen-oxygen engine, which is being used on the Centaur project (chart 20, Research Contributed to Centaur Rocket Engine), and which will also be used for the upper stages of Saturn.

CHART 20



The tremendous potentialities of hydrogen as a high-energy fuel have been recognized for a long time, since far back in the last century, as a matter of fact. However, the apparent hazards associated with its use and difficulties of handling hydrogen tended to discourage its consideration as a practical fuel.

Roughly 10 years ago, the Atomic Energy Commission's requirements for liquid hydrogen led to research which found out how to handle and make liquid hydrogen in a reasonably practical way.

Encouraged by these results, the NACA undertook in 1953 to see whether liquid hydrogen could be used to improve the rocket engine. We found it necessary, first, to do a great deal of basic research on the heat capacity of liquid, boiling, and gaseous hydrogen in order to find out how to design the cooling passages to cool the combustion chamber and nozzle.

As a result of this work, we find it possible to generate mathematical procedures for the designs of these passages. The very hot and short oxygen-hydrogen flame resulted in the destruction of the first injector plates, through which the fuel is introduced into the combustion chambers, and a great deal of work had to be done to find out how to cool them.

As a result of this work, it was possible to operate successfully at the Lewis Laboratory in November 1957 a 5,000-pound laboratory thrust chamber.

Incidentally, that chamber is over there on the table in a partly disassembled form so you can see it a little better.

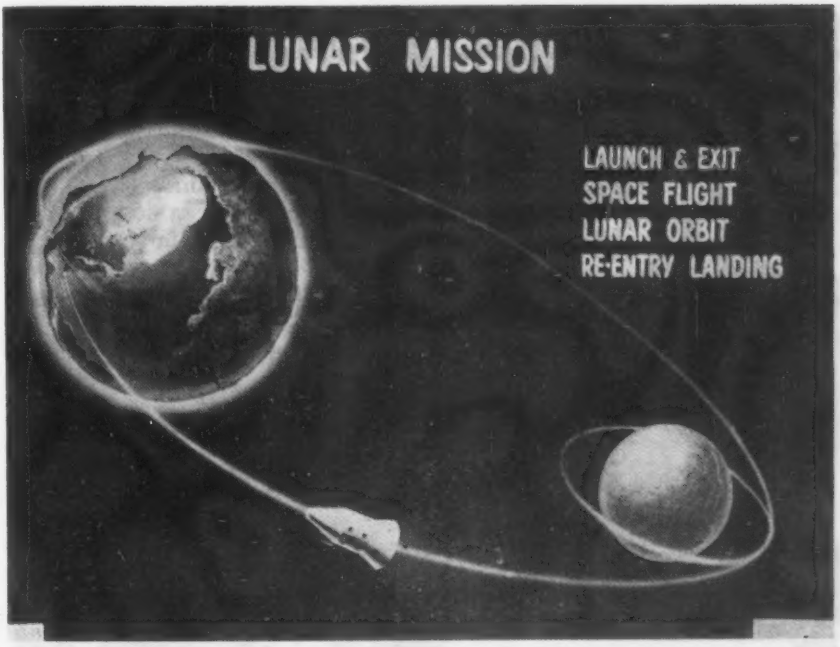
Because of the small size of this experiment, a 20,000-pound thrust chamber was built and also operated at the end of 1957. As a result of this work, the military entered into a contract with Pratt & Whitney to develop the Centaur flight engine in 1958. As indicated by this arrow, the contractor has been able to make exceptionally rapid progress in the development of this engine. The result is that many of our hopes for future space activity are now centered around the hydrogen rocket. As was stated earlier, these rockets are going to be used for the upper stages of the Saturn project.

RESEARCH PROBLEMS OF A LUNAR MISSION

I would now like to turn briefly to some of our current research which we expect to be paying off in the future.

As an example of this I will take the lunar mission, which is only one of the many missions which we have to support by our research activities.

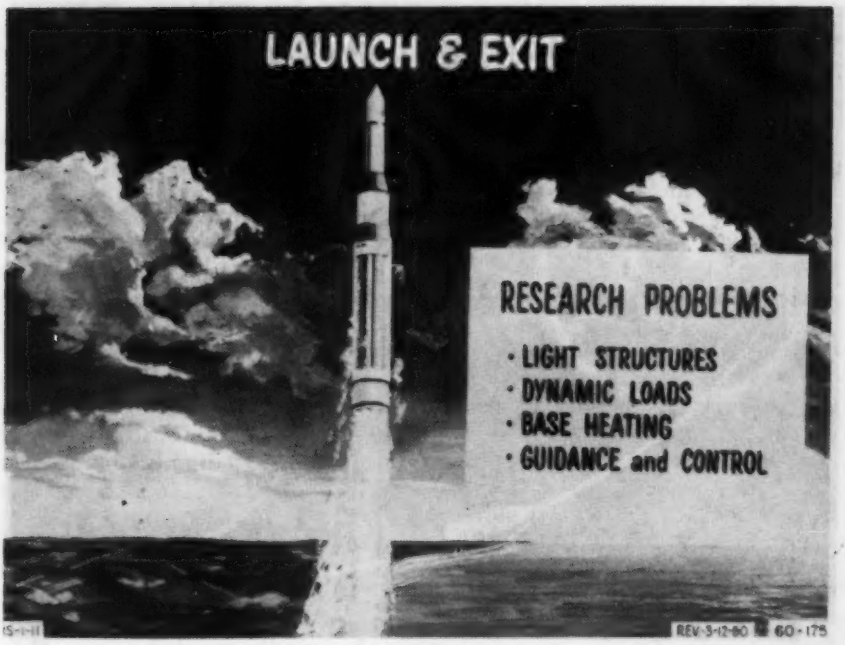
CHART 21



As indicated on this chart (chart 21, Lunar Mission) the lunar mission involves many phases—the launch and exit, the space flight itself, the lunar orbit, which may include, as this type of mission progresses, the landing of instruments on the Moon and other means for exploration of the lunar surface to include, finally, the landing of men on the Moon. And, finally of course, whatever the detailed mission, we have the reentry back into the Earth's atmosphere and landing.

Now, there are many imposing research problems in all these phases of flight. In order to be brief here, however, I will talk about only two phases—the launch and exit phase and the reentry and landing phase.

CHART 22



Let us consider first the launch and exit (chart 22, Launch and Exit). The lunar mission will require a very large vehicle, such as the Saturn, including appropriate upper stages, and an appropriate space vehicle, together with the contents. This vehicle will be very large and heavy. It may be of the order of 300 feet tall, and weigh about a million pounds. Because of the extreme importance of weight, the structure of such a vehicle will be very light and flimsy by normal standards. The vehicle will be balanced on its rockets with a thrust of something like a million and a half pounds, and will also be subject to the side forces resulting from the gimbling of these rockets, which control and stabilize the vehicle.

The vehicle will also be subject to wind shears as it passes up through the turbulent atmosphere which will impose side loads of a dynamic nature on the vehicle.

We have many research problems here. They include the information necessary to design and build such light structures, the identification of the dynamic loads, and the effect of the dynamic loads on the control and guidance system with which they interact. The base heating problem is a very troublesome one, requiring tests in large wind tunnels to assure these very hot flames do not destroy the rear end of the rocket.

And the guidance and control problem which is intimately related with the vibrations resulting from the dynamic load also requires research. We are working on these problems and many others, both in direct support of the Saturn project and also to provide additional information for future vehicles.

THE PROBLEM OF REENTRY

We turn now to the reentry problem. One way of reentering the Earth's atmosphere would be a direct extrapulation of our experience with Project Mercury, by using a ballistic-type capsule, which I have shown on this chart. Studies at our research centers indicate that if this attempt were made, the major problem would be that of guidance. In any case, the high velicities of reentering from a lunar mission (chart 23, Reentry from the Moon, Condition A), as compared with a satellite such as the Mercury project, would impose much more severe problems of all kinds.

CHART 23—CONDITION A

Let us consider what would happen if we tried to reenter with a ballistic-type vehicle such as that used for Mercury. Our calculations indicate that, in order to circle the Earth and land successfully, this vehicle would have to approach along a corridor which is only about 7 miles wide. That is, it would be permitted an error of only 3½ miles on each side of the proper course.

To give you some idea of the scale, this 7 miles is less than one-thousandth of the diameter of the Earth. On this chart, the width of this corridor has been exaggerated about 10 times so you can see it.

If the vehicle were to miss this corridor by undershooting it, the vehicle and the occupants would be destroyed by the very high accelerations that would result. However, if the vehicle overshoots the corridor, it will go out again into space with another excursion of perhaps several days through the radiation belts, even it it is possible later to reenter at all.

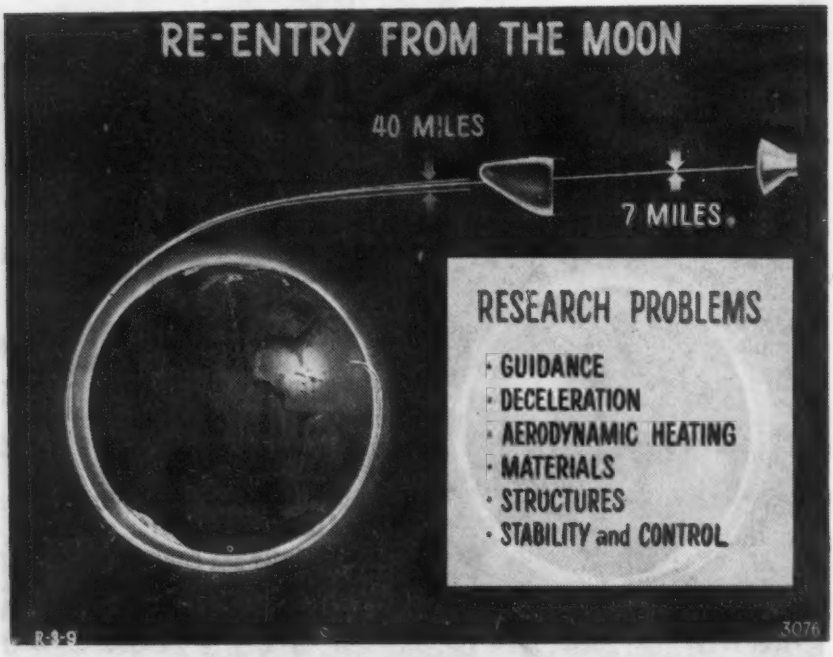
Now, no present-day guidance systems are sufficiently good to permit this kind of accuracy to be achieved in a practical manner for a

vehicle with a human occupant. We are, of course, working to provide better guidance systems.

However, we are also working on other approaches to the problem.

One approach to the problem would be to provide lift for this vehicle by giving it some wings to lift it much the same as the X–15 will lift as it reenters the atmosphere. By this means, it will be possible to widen this corridor to as much as 120 miles or more (chart 24, Reentry from the Moon, Condition B). This would greatly alleviate the guidance problem. Wings would also help the deceleration problem on the vehicle.

CHART 24—CONDITION B



However, the extreme aerodynamic heating that would be imposed on such a vehicle at the speeds involved in returning from the moon would result in conditions for which we know no solutions today. Material and structures are simply not capable today of withstanding this extreme heating. The resulting vehicle would also be heavy, if possible to build at all.

However, it is possible to compromise this situation. We can provide this vehicle with some lift—by using a body such as I have indicated here—to increase the reentry corridor to some reasonable width, such as 40 miles, which would also reduce greatly the deceleration problem.

However, this method does increase the aerodynamic heating problem. Consequently, the materials and structures and the stability and control problems are increased over those encountered with the Mercury project. However, the extent of this complication is such that we feel confident that the research going on today, if properly continued, will solve these problems in a reasonable length of time to permit the design of such a vehicle.

I hope that this very short description of some of our activities will give you an idea of what we do in our advanced research programs.

Senator STENNIS. Well, it gives us a good idea of what you are doing. Thank you very much.

Gentlemen, we have General Ostrander here, who is Director of the Office of Launch Vehicle Programs.

General, if you would like to come around now, we will let you proceed in your own way.

STATEMENT OF MAJ. GEN. DON R. OSTRANDER, USAF, DIRECTOR, LAUNCH VEHICLE PROGRAM

General OSTRANDER. Mr. Chairman, I will discuss for you NASA's launch vehicle program, for which I am responsible. This program includes not only the development of the vehicles themselves, which Dr. Glennan reviewed briefly for you, but also a program of advanced technology necessary to support both these vehicles, and vehicles even further in the future than we are presently able to describe in definite form.

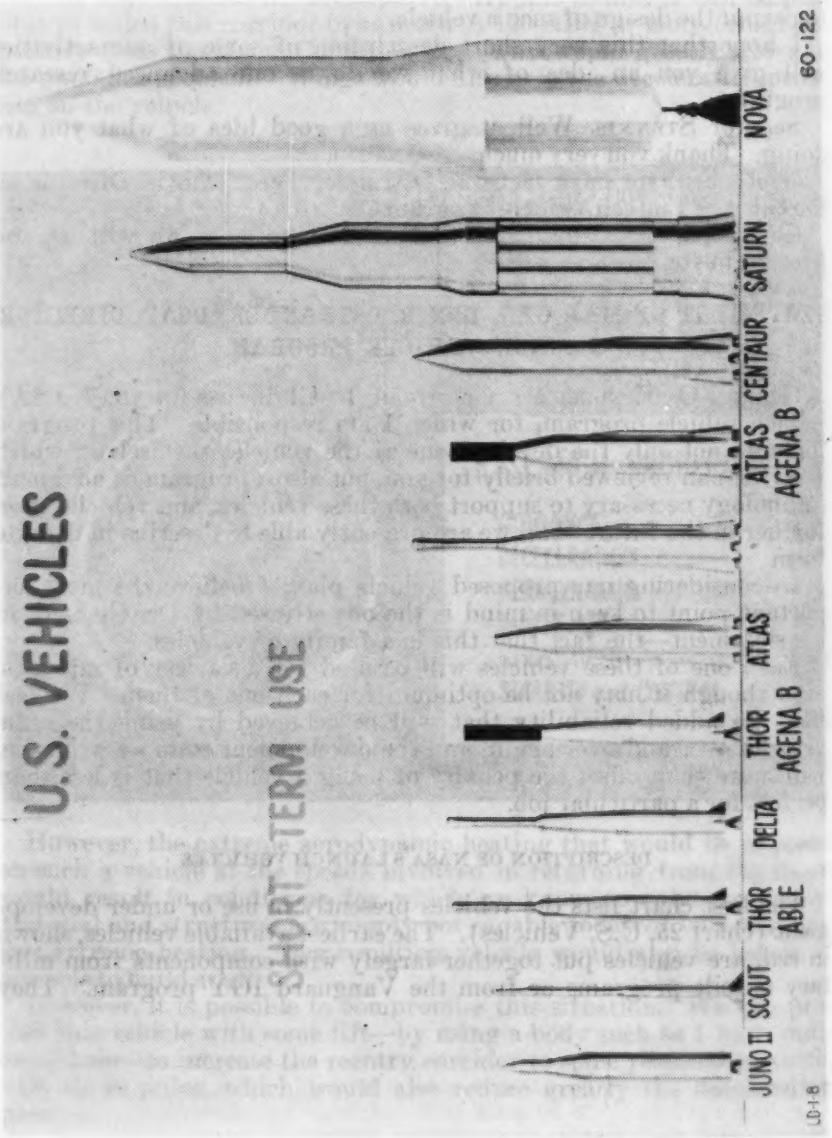
In considering our proposed vehicle plan, I believe the most important point to keep in mind is the one stressed by Dr. Glennan in his statement—the fact that this is a family of vehicles.

Each one of these vehicles will be used for a variety of missions, even though it may not be optimum for each one of them. We feel that the added reliability that will be achieved by using the same vehicles over and over again, and the development costs we will save, will more than offset the penalty of using a vehicle that is less than perfect for a particular job.

DESCRIPTION OF NASA'S LAUNCH VEHICLES

The first chart lists the vehicles presently in use or under development (chart 25, U.S. Vehicles). The earliest available vehicles, shown in red, are vehicles put together largely with components from military missile programs or from the Vanguard IGY program. They

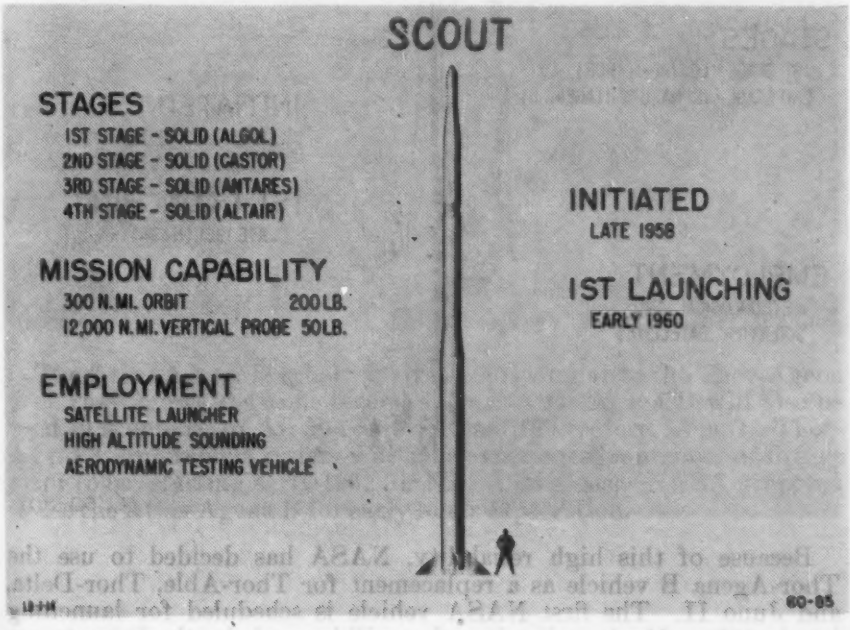
CHART 25


U.S. VEHICLES
SHORT TERM USE
JUNO II
SCOUT
THOR ABLE
DELTA
THOR AGENA B
ATLAS
ATLAS AGENA B
CENTAUR
SATURN
NOVA
60-122
LD-1-8

will have interim use only, and, as time goes on, will be phased out of our inventory. The remaining ones, shown in blue, constitute the continuing vehicle program I mentioned, and they are the ones I would like to review for you today.

The Scout (chart 26) is a four-stage, solid-propellant, launch vehicle. Its chief advantage over other systems is its low cost. The cost in production of launching costs and the vehicle itself may be as low as $500,000, and, even with the associated launching costs, each shot will probably not cost us over $700,000. The Scout development was initiated in late 1958, and the first launching is planned for early this year.

CHART 26



Senator STENNIS. General, you are with the Air Force? You are attached—is that the right word—temporarily to NASA?

General OSTRANDER. Yes, sir; I am detailed to duty with Dr. Glennan in the NASA.

Senator STENNIS. You are responsible for this category, as has already pretty well been pointed out.

General OSTRANDER. Yes, sir.

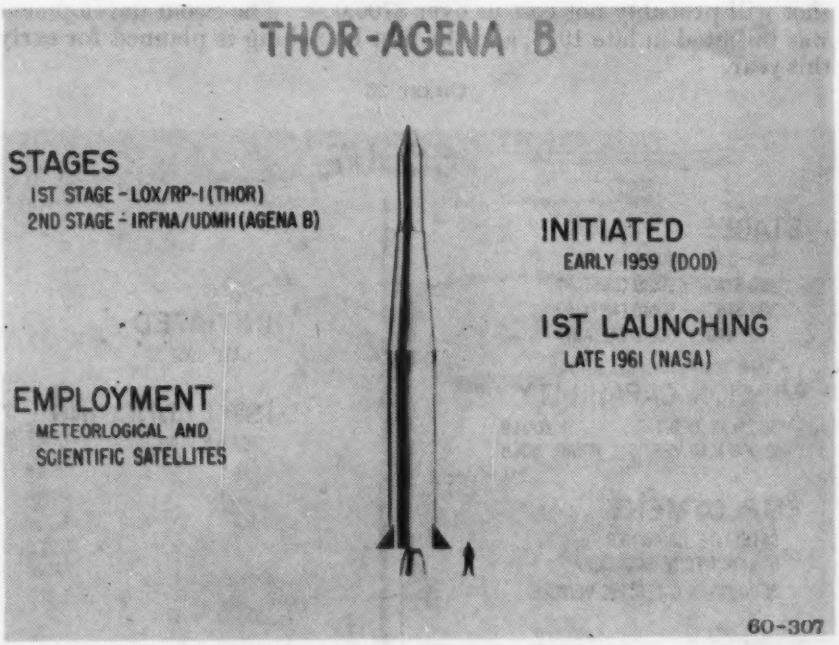
Senator STENNIS. Thank you.

Senator MARTIN. Does the figure there have reference to a calendar year?

General OSTRANDER. Yes, sir. This vehicle, as you notice, will give us something in the order of 200 pounds into a 300-mile earth orbit. Scout can also be used as a vertical probe. The Air Force will also use various configurations of the Scout vehicle in its test programs, giving us an additional advantage of increased usage with its consequent higher reliability.

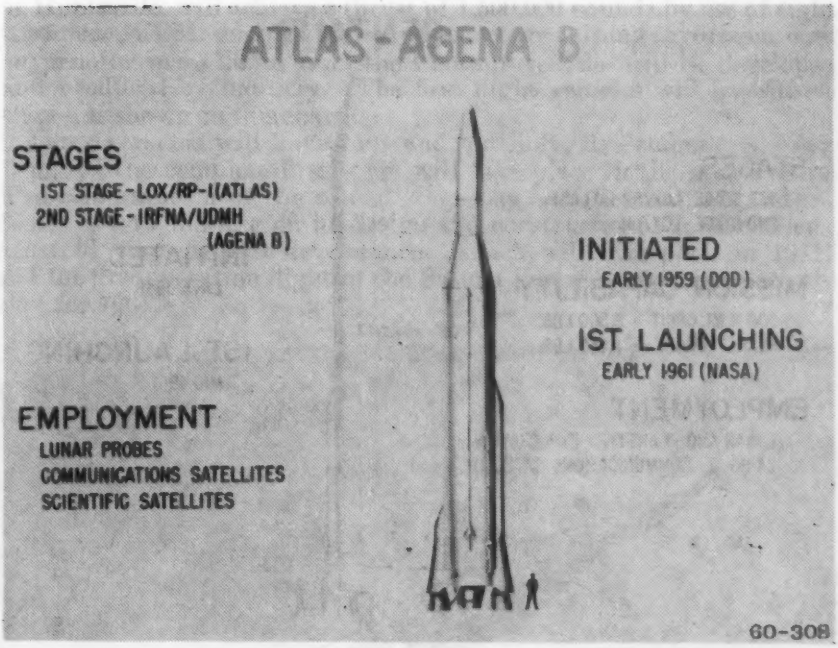
The Thor-Agena B (chart 27) vehicle comprises a Thor IRBM and a second-stage vehicle which is basically the same as the second-stage vehicle used in the Air Force Discoverer satellite vehicle with considerable success. This vehicle was initiated by the Air Force for the Advanced Research Projects Agency in early 1959. The many Discoverer flights have indicated a high reliability for putting payloads into orbit.

CHART 27



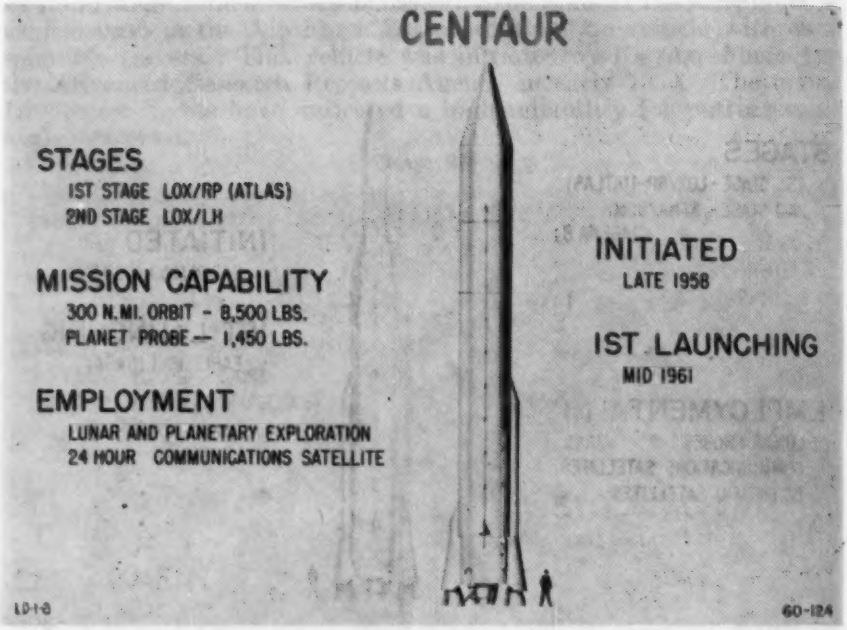
Because of this high reliability, NASA has decided to use the Thor-Agena B vehicle as a replacement for Thor-Able, Thor-Delta, and Juno II. The first NASA vehicle is scheduled for launching late in 1961. Much earlier launches will be made by the Department of Defense. The Thor-Agena B will be used primarily for scientific and meteorological satellite missions.

CHART 28



The Atlas-Agena B (chart 28) vehicle is similar to the Thor-Agena B in that it uses the same second stage. Atlas-Agena B will also be used in a number of Air Force programs. Therefore, as in the Thor-Agena B, the vehicle system will have experienced a number of firings prior to use starting early 1961 for NASA missions. NASA proposed to use the Atlas-Agena B for early lunar exploration.

CHART 29



Centaur (chart 29) is a two-stage vehicle, with Atlas as a first stage and an advanced second stage which will use hydrogen and oxygen as propellants. The Centaur program includes both the development of the engine using these high-energy propellants, and the development of the vehicular stage itself. The design of the engine is complete, and full-duration operation of the engine at rates thrust has already been accomplished. The engineering design of the stage is also nearing completion.

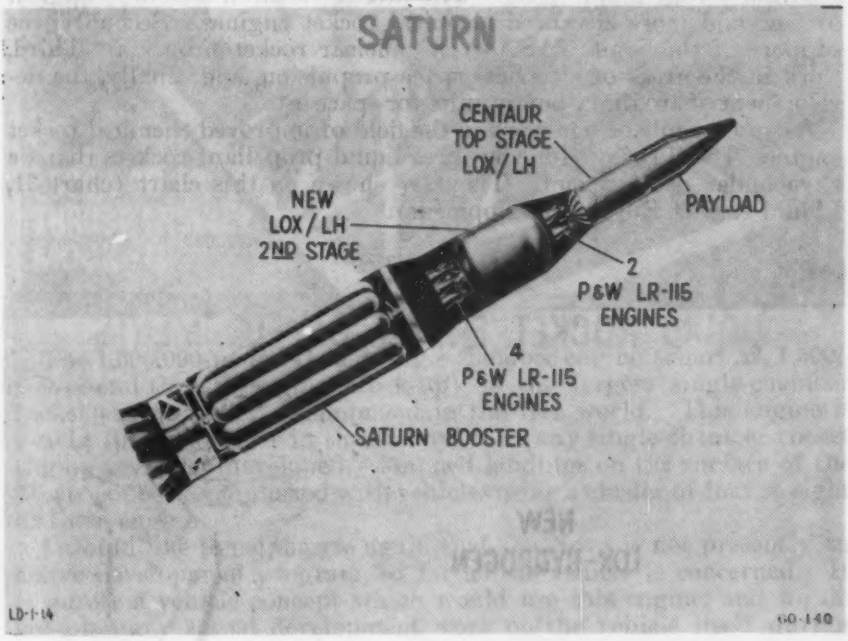
The Centaur project was initiated in late 1958. In July 1959, responsibility for the project was transferred to NASA, but we have continued to use the same Air Force project development team to manage the program. The Air Force will use the Centaur for a communications satellite program. NASA will use the Centaur in lunar and planetary missions.

The Saturn project, undertaken under the responsibility of the Advanced Research Projects Agency in 1959 and now under the management of NASA, is this country's most ambitious active space-vehicle project. The program comprises a series of multistage launching vehicles of increasing payload capability.

The first stage, under development by Dr. von Braun's organization at Huntsville, will achieve a thrust of 1,500,000 pounds by use of eight modified ICBM engines. The upper stages, using hydrogen and oxygen for propellants as in the Centaur vehicle, will be developed and produced by industry. The first flight vehicles will have three stages, as shown on this chart.

Later versions will have four and, possibly, five stages. A static firing of the complete first stage will take place in the near future. The configuration of the second stage has been determined, and industry is now bidding on its design and construction. As Dr. Glennan told you, the first development launch will take place in 1961, and the first operation flight of the Saturn (chart 30) system is scheduled for 1964.

CHART 30



Dr. von Braun will discuss the Saturn in more detail in his presentation.

In addition to the development of specific vehicles, our program includes continuing propulsion technology work which provides the technological background for the development of these and more advanced vehicles.

Senator STENNIS. General, before you proceed, what was the name of that one that you spoke of a while ago with the possibility of 10 million pounds thrust?

General OSTRANDER. This, I was going to cover later on. It was the Nova vehicle concept.

Senator STENNIS. I see.

General OSTRANDER. Actually, this is a concept only, and we are developing only the engine, at present.

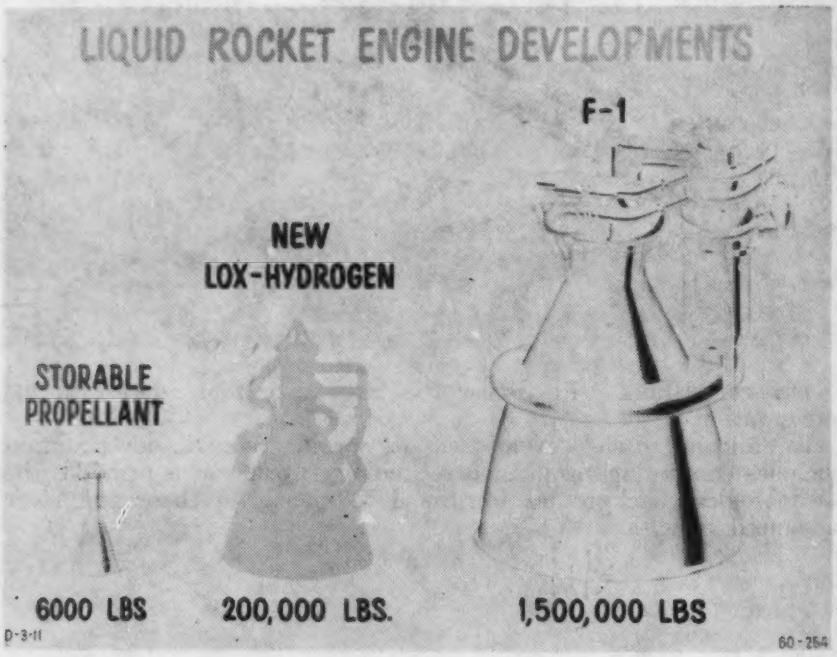
Senator STENNIS. Thank you.

ADVANCED TECHNOLOGY IN ROCKET ENGINES

General OSTRANDER. This field of advanced technology includes essentially four major areas. The first is research and development of new and more advanced chemical rocket engines. Secondly, the support of the joint NASA–AEC nuclear rocket program. Third, work in the areas of electrical space propulsion, and, finally, the development of auxiliary power units for space use.

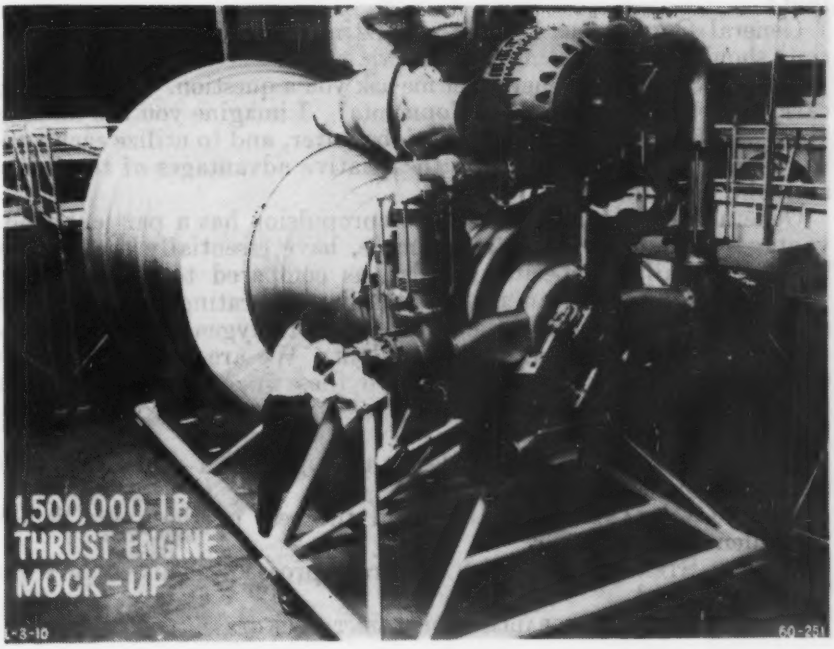
As an example of our work in the field of improved chemical rocket engines, I will review for you three liquid-propellant rockets that we have under development. They are shown on this chart (chart 31, Liquid Rocket Engine Development).

CHART 31



One of these is the 1,500,000-pound-thrust, single-chamber engine; the second is the 200,000-pound-thrust, hydrogen-oxygen engine which will be used in the upper stages of Saturn; and the third is a 6,000-pound-thrust, storable propellant engine.

CHART 32



The 1,500,000-pound-thrust single chamber engine (chart 32, 1,500,000-pound-thrust Engine Mock-up) is the largest single-chamber rocket engine under development in the free world. This engine is nearly 10 times larger in thrust level than any single-chamber rocket engine presently developed. Manned landings on the surface of the Moon can be accomplished with vehicles using a cluster of four to eight of these engines.

I would like to emphasize again that the Nova is not presently an active development program, so far as the vehicle is concerned. It is purely a vehicle concept which would use this engine, and we do not plan any actual development work on the vehicle itself during 1961, although we do have continuing studies on its configuration.

Senator MARTIN. Excuse me, what was the thrust on the Nova?

General OSTRANDER. It will be anywhere from 6 to 12 million pounds, depending upon how many of these engines are used.

The engine has been under development since early 1959. We have had tests of the thrust chamber at thrust levels above 1,000,000 pounds. First full-thrust tests of the complete engine are scheduled at Edwards Air Force Base for spring of 1961. The photograph shows the engineering mockup of the complete engine and affords an idea of its physical size.

A 200,000-pound-thrust hydrogen-oxygen rocket development program will be initiated within the current fiscal year. Bids and proposals have been solicited for seven major rocket contractors.

The 200,000-pound-thrust engine will be used in upper stages for the Saturn vehicle which I mentioned previously. Use of high-energy propellants will virtually double the payload capability of each stage when compared to use of oxygen and kerosene.

Mr. LEHRER. General, when did you expect to let the contract for that?

General OSTRANDER. We are evaluating the bids now. The contract should be let sometime next month.

Senator STENNIS. General, let me ask you a question. Why do you carry on so many of these developments? I imagine you are looking for that which will do the various jobs better, and to utilize each type to its fullest extent. What are the relative advantages of the liquid and solid engines?

General OSTRANDER. Each type of propulsion has a particular advantage. Liquid rockets, for example, have essentially the highest presently available specific impulse, as compared to solid rockets, which have certain advantages in handling, operating, shipping, and so on. We are going into the hydrogen and oxygen because it gives us more thrust per pound of propellant. We are also working on storable propellants, because we need these in operations in space where you have to operate a long time and do not want your propellants to evaporate.

Senator MARTIN. These vehicles on the right chart—the Scout rises on solid propellants, does it not?

General OSTRANDER. Yes, sir. All the rest of these are liquid-propellent vehicles.

Senator STENNIS. All right, General; proceed. This is very interesting, indeed.

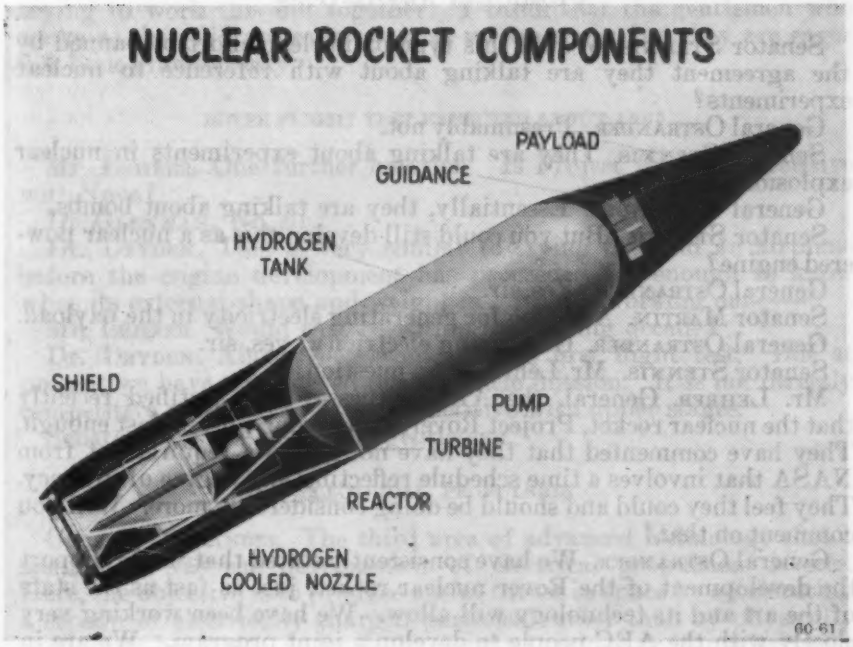
STORABLE PROPELLENT ROCKETS

General OSTRANDER. A storable propellent rocket stage of 6,000 pounds thrust has been under development since early 1959 at the Jet Propulsion Laboratory. Originally slated for use in the Vega vehicle, the development of this engine is being continued because of its multiple usefulness in the space program. As I mentioned, storable propellants can be carried over vast distances and extended times without serious loss due to evaporation. The 6,000-pound-thrust, storable propellent rocket will be used for planetary orbits, planetary landings, and for trajectory corrections during the course of the flight.

NUCLEAR HEAT TRANSFER ROCKET

The next area of advanced propulsion technology that I mentioned was the development of a nuclear heat transfer rocket, which is shown on this chart (chart 33, Nuclear Rocket Components). The nuclear

CHART 33



rocket differs from the chemical rocket in that a nuclear reactor, rather than a chemical combustion reaction, is used in it to heat the working fluid, which in this case is hydrogen. I mentioned that hydrogen and oxygen used as propellants can essentially double the thrust available from the propellent combinations we are currently using. The nuclear rocket, in turn, can potentially double the thrust we will get from hydrogen and oxygen.

Senator STENNIS. How far along are you on this nuclear rocket?

General OSTRANDER. We are working with the Atomic Energy Commission on a joint program. The Atomic Energy Commission has the responsibility for ground evaluation of the reactor. In support of this program, we are supplying certain nonnuclear components: pumps, nozzles, and so on. They fired last summer the so-called Kiwi-A, which in essence demonstrated the feasibility of the program.

NUCLEAR POWERED ROCKET DEVELOPMENT NOT AFFECTED BY CURRENT A-BOMB BAN NEGOTIATIONS

Senator STENNIS. Would this type of nuclear effort be banned by the agreement they are talking about with reference to nuclear experiments?

General OSTRANDER. Presumably not.

Senator STENNIS. They are talking about experiments in nuclear explosions.

General OSTRANDER. Essentially, they are talking about bombs.

Senator STENNIS. But you could still develop this as a nuclear powered engine?

General OSTRANDER. Yes, sir.

Senator MARTIN. And also for generating electricity in the payload.

General OSTRANDER. Generating electricity; yes, sir.

Senator STENNIS. Mr. Lehrer has a question.

Mr. LEHRER. General, the AEC witnesses have testified recently that the nuclear rocket, Project Rover, is not being pushed fast enough. They have commented that they have not gotten a requirement from NASA that involves a time schedule reflecting any degree of urgency. They feel they could and should be doing considerably more. Will you comment on that?

General OSTRANDER. We have consistently stated that we do support the development of the Rover nuclear rocket, just as fast as the state of the art and its technology will allow. We have been working very closely with the AEC people to develop a joint program. We are in the process at present of attempting to establish target dates in the program, and I believe that we are arriving at a very close meeting of minds.

NASA HAS RESPONSIBILITY FOR ULTIMATE USE OF A NUCLEAR-POWERED VEHICLE

Mr. LEHRER. If AEC thinks you should be going faster, who makes the decision as to what the appropriate rate is?

General OSTRANDER. I feel that the decision on the ultimate use of a nuclear rocket, within the context of our overall mission responsibility, must be the prerogative of NASA. The nuclear rocket is, in some cases, complementary to our other programs. In some cases, it may be, in a sense, competitive with other forms of propulsion.

Mr. LEHRER. Is the fact that a nuclear rocket is not included in the 10-year plan which Dr. Glennan outlined, an indication that you don't consider it to be feasible or important during that time period?

Dr. GLENNAN. I'm sorry. It is in the 10-year program. It doesn't happen to be on this chart. It is covered in the program itself, however, Mr. Lehrer. I think this is, perhaps, a point at which one should say that I think it is quite normal that the Atomic Energy Commission should be concerned that that particular area of responsibility be the area to get the most effort. What we are faced with is: What are you going to use this for? We think we know. When will you be able to use it? This, we are attempting to determine. But we really cannot give them a mission assignment until we know what the reactor is going to look like.

We are a little bit in the chicken-and-the-egg situation, and we are trying to work this out together. I think that the gentlemen who spoke as they did are eager, just as we are eager, but they are eager in a little different way.

ROVER FLIGHT TEST EXPECTED ABOUT 1965

Mr. LEHRER. One further question. Is Project Rover competitive with Nova?

Dr. GLENNAN. No, sir.

Dr. DRYDEN. This is very similar to trying to build an airplane before the engine development has proceeded far enough to know what its external shape and weight is. We are working out——

Mr. LEHRER. Would that be within the coming decade?

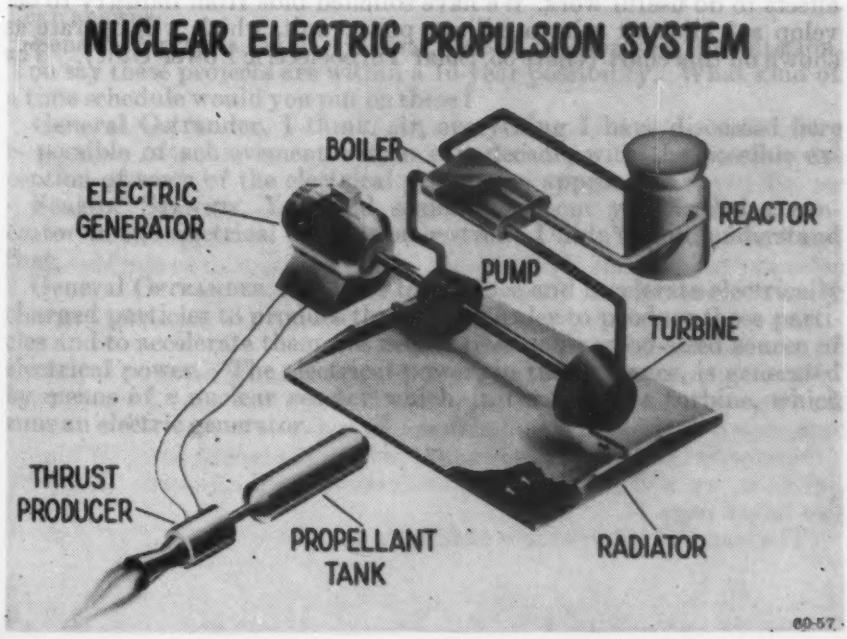
Dr. DRYDEN. About 1965 would be the first flight test. But at present we have not worked out a vehicle mission. It is not directly competitive with Nova. It is competitive with upper stages.

Senator STENNIS. All right, gentlemen.

ELECTRICAL PROPULSION

General OSTRANDER. The third area of advanced technology that I mentioned was the development of electrical propulsion devices. Here, the objective is to produce useful thrust in space by accelerating a stream of electrically charged particles, rather than by physically expanding hot gases, as we do in chemical rockets or in nuclear heat transfer rockets. We, of course, need a basic source of electrical power to charge the particles and accelerate them. The most probable source of this power is nuclear-power generation as shown on this chart (chart 34, Nuclear Electric Propulsion System).

CHART 34



By focusing the travel of this stream of charged particles, they can be caused to leave the apparatus at extreme velocities, of the order of hundreds of thousands of miles per hour. The specific impulse of the electrical rockets is very high, from 2,000 to 20,000 pound-seconds per pound, as compared to about 450 pound-seconds per pound for hydrogen-oxygen chemical rockets, and about 900 pound-seconds per pound for nuclear rockets. However, because of the small amount of mass that can be acted on with the available power, the total thrust is low. The thrust that can be produced is about one ten-thousandth of the apparatus weight. Consequently, the application of electrical rockets is useful for propulsion only after you are already in space.

Senator STENNIS. Where you do not need as much power.

General OSTRANDER. It provides small amounts of thrust, but continually applied over a long period of time.

AUXILIARY POWER

The fourth and last major area in our advanced technology is the production of auxiliary power, both for the operation of instrumentation and other equipment carried aboard our space craft, and ultimately to act as the basic power source for the electric propulsion devices I just mentioned.

We are attacking this problem with basically two approaches. First, we are working on several different kinds of nuclear-power generating systems. These include machine-driven systems in which a nuclear-powered turbine is used to drive an electrical generator, and other systems in which the input energy is converted directly to electrical power without a machine.

In addition, we are exploring nonnuclear systems. Since solar energy is available in space, much of our effort is pointed toward focusing this thinly distributed solar energy and concentrating its effects to do useful work. We have solicited bids from industry to develop a 3-kilowatt solar auxiliary power unit, which will operate as shown on this chart (chart 35, Solar Turboelectric Power Unit). The

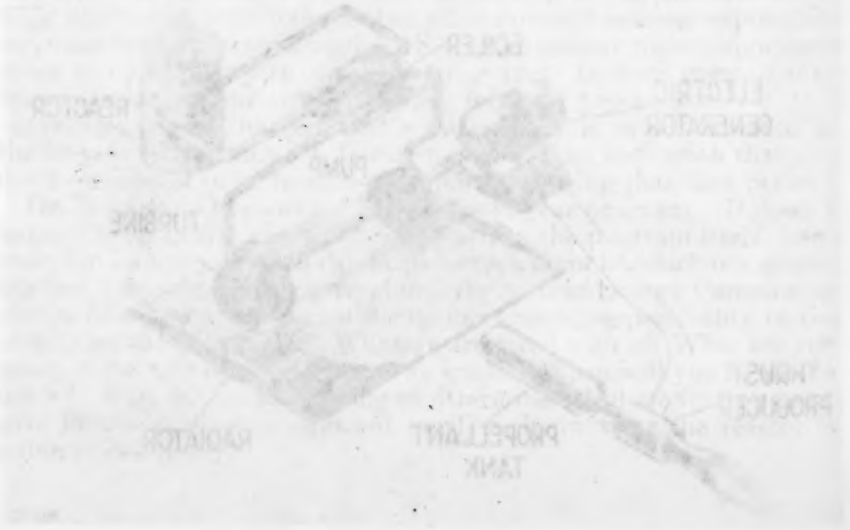
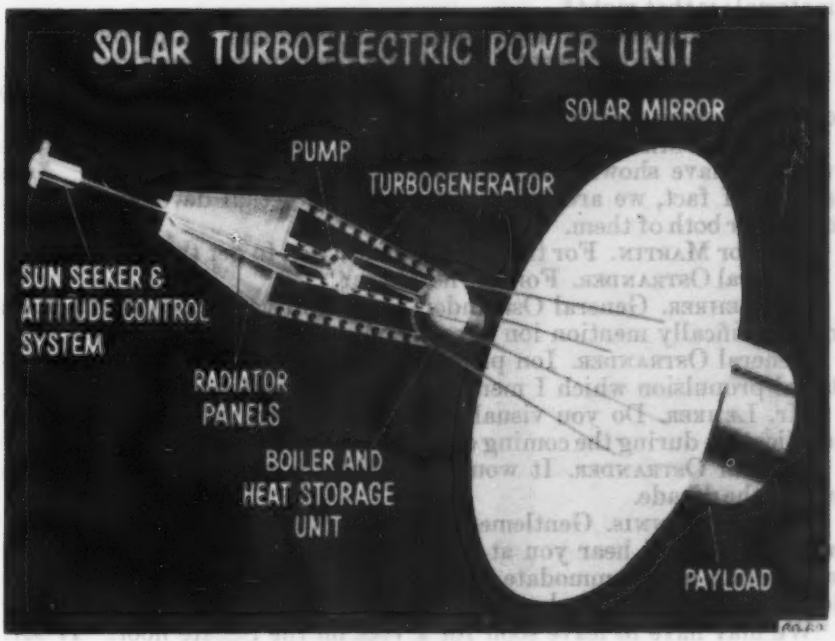


CHART 35



radiant energy of the sun will be focused by a large mirror on a boiler in which a liquid metal is used in the same manner that steam is used to drive a turbine in a large, ground-based, power station. The turbine in turn drives an electrical generator which produces the required power output.

This concludes my presentation, unless there are any questions that I can answer.

Senator STENNIS. Well, General, this is an amazing presentation. You say these projects are within a 10-year possibility. What kind of a time schedule would you put on these?

General Ostrander. I think, sir, everything I have discussed here is possible of achievement within this decade, with the possible exception of some of the electrical propulsion approaches.

Senator STENNIS. You said something about you needed a generator in the electrical propulsion system. I didn't quite understand that.

General OSTRANDER. We have to produce and accelerate electrically charged particles to produce thrust. In order to produce those particles and to accelerate them, we need a reasonably good-sized source of electrical power. The electrical power, in this instance, is generated by means of a nuclear reactor which, in turn, runs a turbine, which runs an electric generator.

Senator STENNIS. And the generator helps produce the thrust material; is that right?

General OSTRANDER. That is right; it produces the power.

Senator STENNIS. Senator Martin, do you have any questions?

Senator MARTIN. The only question I have is that these last two charts are some years away. You say they are in this decade?

General OSTRANDER. I think that both of the generating systems which I have shown are achievable well within this decade. As a matter of fact, we are in process of letting actual development contracts for both of them.

Senator MARTIN. For the coming fiscal year, to get them started?

General OSTRANDER. For this fiscal year.

Mr. LEHRER. General Ostrander, I noted in your discussion you do not specifically mention ion propulsion. How does that fit in?

General OSTRANDER. Ion propulsion is one of several forms of electrical propulsion which I mentioned. It is one possible approach.

Mr. LEHRER. Do you visualize ion propulsion as having practical application during the coming decade?

General OSTRANDER. It would probably be well along toward the end of the decade.

Senator STENNIS. Gentlemen of NASA, we are not hurrying this up at all. We will hear you at any length you wish to be heard. We would like to accommodate you at this hearing today and cover at least the highlights of what you want to present.

We may have to leave soon for a vote on the Senate floor. If Mr. Lehrer or Senator Martin have any questions that they would like to submit in writing, perhaps we could handle it that way and have the answers placed in the record.

Senator Martin, do you have anything further?

Senator MARTIN. No.

Senator STENNIS. Do you gentlemen have something further to say now?

PROPULSION DEVELOPMENTS AND OPERATIONS TO BE ASSIGNED TO THE MARSHALL SPACE FLIGHT CENTER

Mr. HORNER. Mr. Chairman, we have one additional major area of our program to be covered. The witnesses are not here this afternoon, but will be here the first thing in the morning.

In the area that we have covered, the one which General Ostrander was just talking about, I think, for the sake of completeness, it is necessary to note that all of this work will be assigned to the Marshall Space Flight Center at Huntsville for completion.

There is in this budget a proposed major facility expansion to the extent of about almost $27 million.

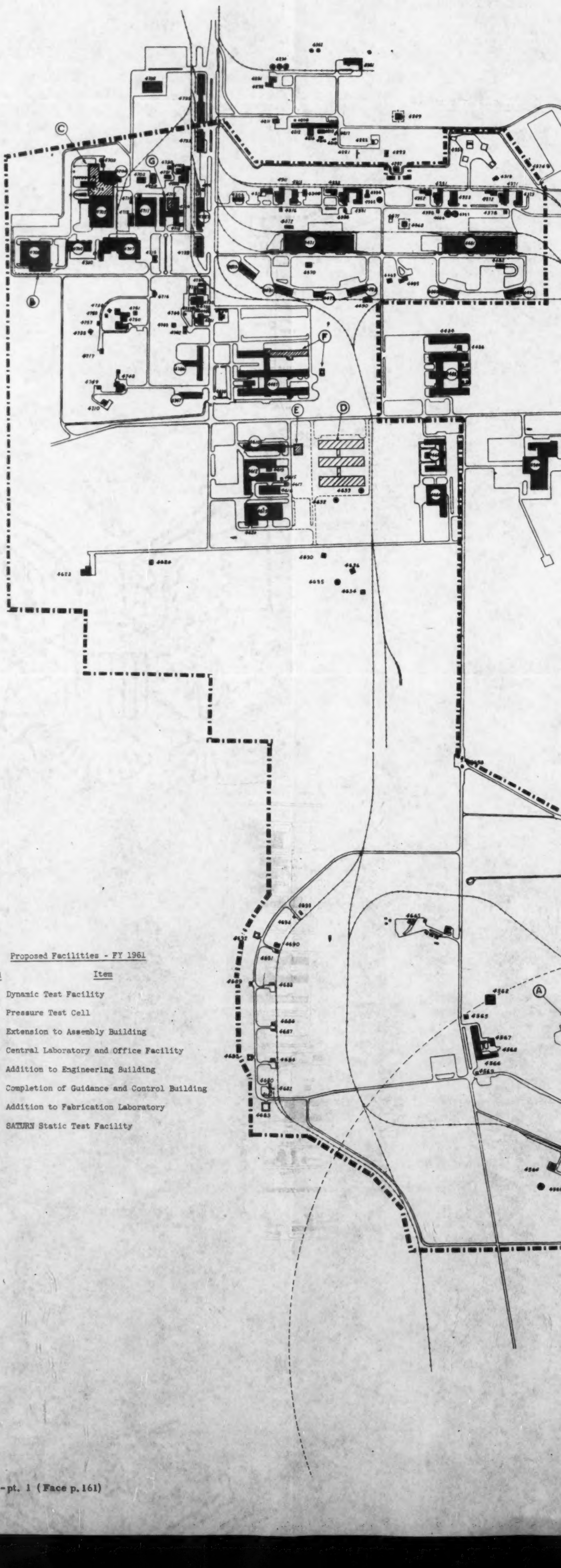
Now, the requirements, in detail, for those facilities, are set out in the appropriations book on pages 379 through 411, and I would like to suggest that those be included in the record.

Senator STENNIS. Yes; they ought to be in the record here. Without objection, we will insert those justifications in the record. We will also insert page 47.

(The material referred to is as follows:)

NASA HUNTSVILLE
FISCAL YEAR 1961

SITE PL

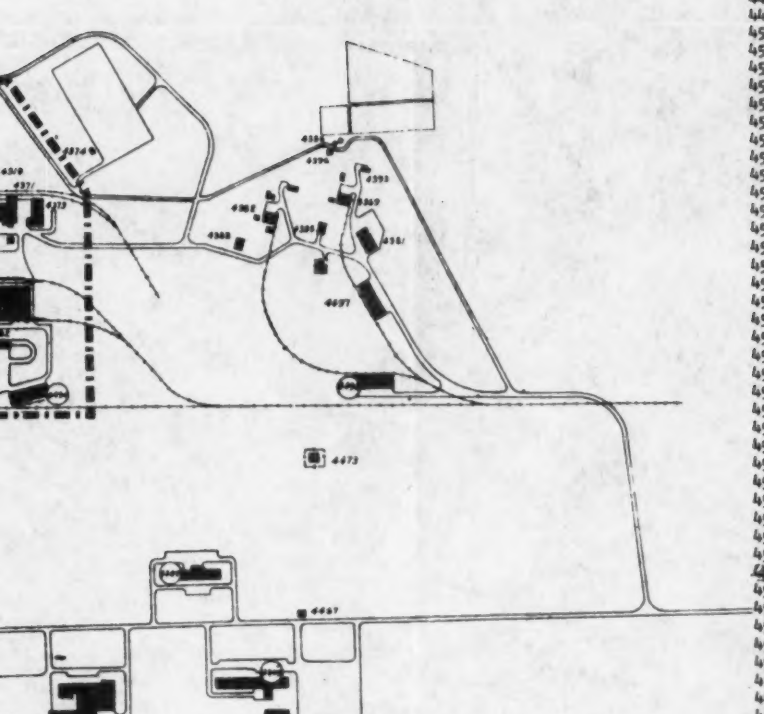


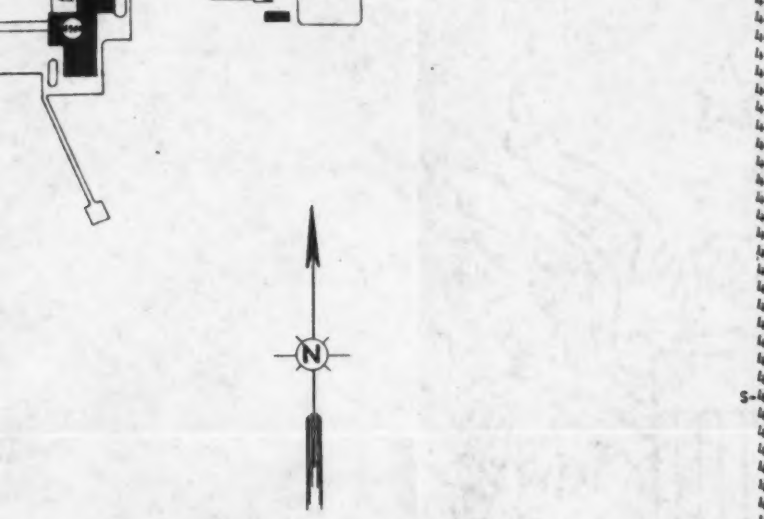
Proposed Facilities - FY 1961

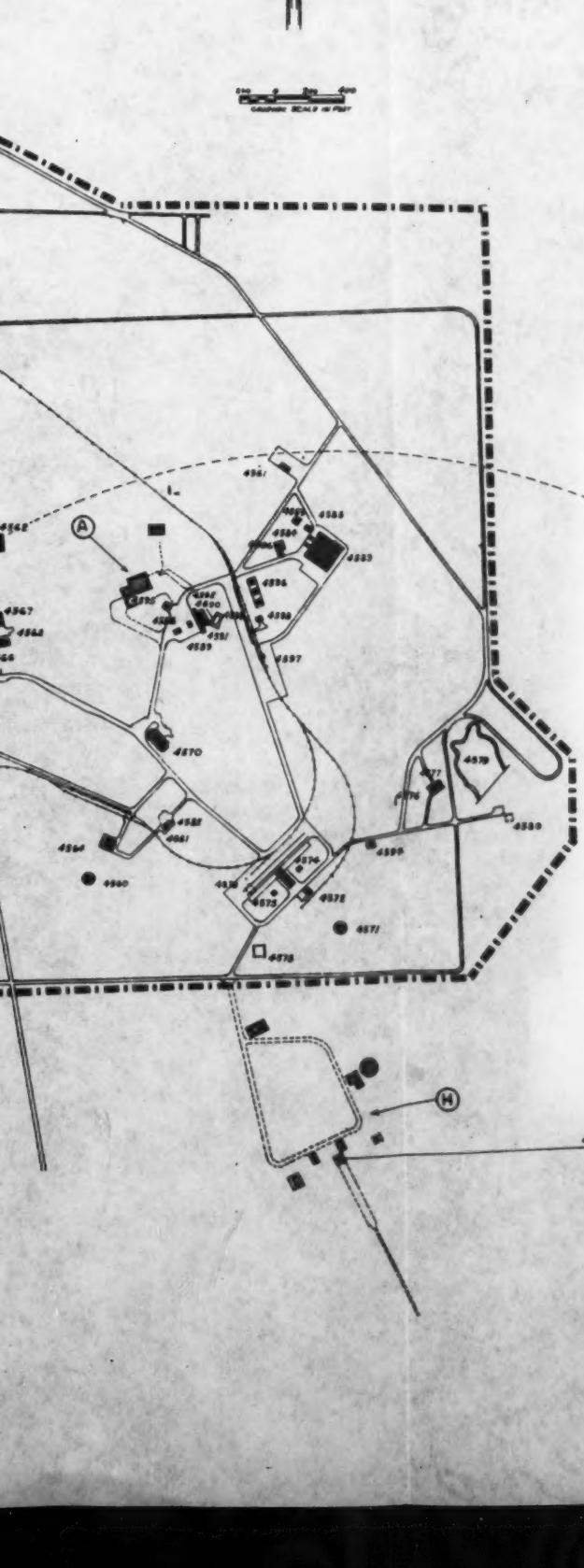
Legend	Item
(A)	Dynamic Test Facility
(B)	Pressure Test Cell
(C)	Extension to Assembly Building
(D)	Central Laboratory and Office Facility
(E)	Addition to Engineering Building
(F)	Completion of Guidance and Control Building
(G)	Addition to Fabrication Laboratory
(H)	SATURN Static Test Facility

HUNTSVILLE FACILITY
YEAR 1961 ESTIMATES

ITE PLAN







EXISTING FACILITIES

INDEX

BLDG. NO.	TITLE
4306	Cafeteria
4309	Engine Test
4311	Supply & Equipment Reclassification
4312	Security Guard Hq.
4313	Rocketdyne Service Center
4316	Storage, Paint
4319	Oil Pump Sta. (Test Branch)
4331	Testing & Dev. Shop
4332	Environmental Test Lab
4334	Test Tower Instrumentation
4335	Centrifuge - 50,000 cu ft
4336	High Pressure Test
4350	Fuel Test Stand
4351	Supply Mgt - Catalog & Pub.
4352	Nitrogen Manufacturing Plant
4353	Maintenance
4354	Nitrogen Storage Tank (Surplus)
4355	Nitrogen Storage Tank (Surplus)
4356	Storage
4371	Trans. & Packaging
4372	Receiving Unit
4373	Ground Support Equipment Lab
4376	H S Scrubber
4424	Fire Station
4435	Motor Pool Building
4469	Maintenance Shop
4470	Shelter Shear
4471	Warehouse & Office
4472	Packaging & Preservation
4479	Storage Shed (Bottle Gas)
4481	SSE Lab & Engr. Ofc.
4482	Operations Support
4485	Electrical Systems Lab
4487	G&C Office, Lab, & Shops
4490	R R Track Scales
4491	Computing Eq. Building
4492	Wiring Lab.
4493	Machine Shop
4494	Warehouse
4495	Maintenance Shop
4559	Vacuum Pump House
4560	Observation Bunker
4561	Shop - Support Facility
4562	Industrial Water Storage
4564	Horizontal Test Stand
4566	Engineering Building
4567	Boiler House & Pump Station
4568	Sub-Station - 44 KV
4569	Guard House
4570	Blockhouse
4571	Observation Bunker
4572	Static Test Tower
4573	Static Test Tower Gantry Crane
4574	Static Test Tower Fuel Disposal Pit
4575	Static Test Tower Oxidizer Disposal Pit
4576	Liquid Waste Disposal Collection Tank
4577	LWD Sand Filter
4578	Liquid Waste Disposal Underground Tanks
4579	Liquid Waste Disposal Reservoir
4580	Liquid Waste Disposal Mix Chamber
4581	Nitrogen Booster Battery
4582	NBB Compressor Building
4583	Components Test Laboratory
4584	Components Test Lab Catch Tank Pit
4585	Components Test Lab Concrete Holding Pond
4586	Components Test Lab Earthen Holding Pond
4588	Cold Calibration Test Stand
4589	Cold Calibration Test Stand Observation Bldg
4590	Pit
4591	Cold Calibr Test Stand Oxidizer Dispsl Pit
4592	Cold Calibr Test Stnd Fuel Dispsl Pit
4593	Cold Calibr Test Stnd Earthen Holding Pond
4594	Fuel Storage Facility
4595	Static Test Observation
4596	Oxidizer Ready Storage
4597	Fuel Ready Storage - 10,000 Gallons
4598	Nitrogen Gas Ready Storage
4610	Engineering Office Unit
4612	Engr. Development Unit
4613	Compressor Building
4615	Cooling Tower
4616	Shop Unit
4617	Flammable Storage
4619	Structural Test Lab.
4620	Vacuum & Compressor Bldg.
4623	Accelerator & Test Cell Facility
4624	Shed - H_2O_2 Storage
4630	Gasoline Pumping Building
4632	Gasoline Storage Tank (to be removed)
4633	Gasoline Storage Tank (to be removed)
4634	Diesel Pumping Building
4635	Diesel Storage Tank
4636	Sewage Lift Station
4650	Guided Missile Test Shop
4658	Guard House
4663	Computation Lab
4665	Interim Test Stand
4680	Hydrogen Peroxide Tank Shelter
4681	Hydrogen Peroxide Tfr. Pump House
S-4682	Unloading Dock
4683	Hydrogen Peroxide Earthen Disposal Pond
4684	Nitric Acid Drum Storage
4685	Nitric Acid Disposal Pond
4686	Liquid Oxygen Tank Pit
4687	Liquid Oxygen Storage Tool Shelter
4688	Aniline-Furfuryl Drum Storage
4689	Aniline Furfuryl Disposal Pond
4690	Ethyl Alcohol Tank Shelter
4691	Ethyl Alcohol Transfer Pump House
4692	Ethyl Alcohol Disposal Pond
4693	Hydro Carbon Storage Tank
4694	Hydro Carbon Storage Tool Shelter
4702	High Pressure Test Building
4703	Chemical Cleaning
4704	Hydraulic Press. Building
4705	Missile Assembly Hangar
4706	Missile Assembly Hangar
4707	Structural Fabrication Hangar
4708	Missile Assembly & Inspection Hangar
S-4709	Lunch Room
4710	Test Cell "C"
4711	Development Shop - Precision Machine Shop
4712	Engineering Building
4713	Storage
4714	Cleaning & Treatment Shop
4715	Expediting Office - Reproduction
4716	Storage
4717	Propellant Storage
4718	Oil Storage
4719	Oil Pump Station
4720	Safety Office
4723	Engineering
4725	Steam Plt #1 & Air Comp Bldg.
4726	Turbo-Generator Building
4727	Supply Material & Equipment
4728	Research & Development Shop
4730	Air Compressor & Storage
4731	Storage Shed
4732	Wind Tunnel
4733	Vacuum Tank
4734	Vacuum Pump House
4735	Air Dryer House
4736	Dry Air Storage
4737	Dry Air Storage Tank
4738	Storage
4739	Instrumentation Shop
4741	Shop & Laboratory
T-4742	Chemical Storage
4743	Storage
4744	Compressor Air Facility
4746	Instrumentation Dev & Signal - TV Unit
T-4747	Air Compressor Station
4748	Liquid Propellant Test Stand
4749	Propellant Test Cell
4750	High Altitude Test Facility
4751	High Pressure Air Battery
4753	Combustion Test Block No. 1
4754	Underwater Storage Tank, 118 Bbl.
4755	Combustion Test Block No. 2
4760	Surface Treatment Shop

MARSHALL SPACE FLIGHT CENTER

ESTIMATES OF APPROPRIATIONS - SALARIES AND EXPENSES - FISCAL YEAR 1961

	F.Y. 1959 Obligated	F.Y. 1960 Estimated	F.Y. 1961 Estimated
01 PERSONAL SERVICES:			
Number of permanent positions (end of year)	---	100	5,500
Annual cost of permanent positions (end of year)	---	$727,000	$40,175,000
Deduct lapses	---	525,000	195,000
Net cost of permanent positions	---	202,000	39,980,000
Intermittent employment	---	---	100,000
Regular pay above 52-week base	---	5,600	154,500
Overtime and night-work differential	---	4,400	7,200,000
Other allowances	---	---	5,500
Reimbursable details	---	---	100,000
TOTAL PERSONAL SERVICES	---	212,000	47,540,000
02 TRAVEL	---	---	1,281,000
03 TRANSPORTATION OF THINGS:			
Household goods	---	---	100,000
All other	---	---	2,124,000*
04 COMMUNICATION SERVICES:			
Leased lines	---	---	100,000*
All other	---	---	229,000
05 RENTS AND UTILITY SERVICES:			
Electric power	---	---	---
Other utilities	---	---	---
Rentals	---	---	6,050,000
06 PRINTING AND REPRODUCTION	---	---	---
07 OTHER CONTRACTUAL SERVICES:			
Research contracts	---	---	100,000
Repairs and alterations	---	---	1,800,000*
Miscellaneous services	---	---	5,370,000*
Services by other Government agencies	---	---	2,603,000*
Security investigations	---	---	---
Federal life insurance	---	1,000	132,000
Federal health program	---	---	306,000
08 SUPPLIES AND MATERIALS	---	---	4,000,000*
09 EQUIPMENT	---	---	2,755,000*
11 GRANTS, SUBSIDIES, AND CONTRIBUTIONS	---	14,000	2,570,000
13 REFUNDS, AWARDS, AND INDEMNITIES	---	---	1,000
15 TAXES AND ASSESSMENTS	---	---	4,000
TOTAL	---	$227,000	$77,065,000
Partially (#) or fully funded (*) under "Research & Development"	---	---	-18,752,000
Unobligated balance	---	---	---
TOTAL ALLOTMENT	---	$227,000	$58,313,000

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

SATURN STATIC TEST FACILITY

1. DESCRIPTION:

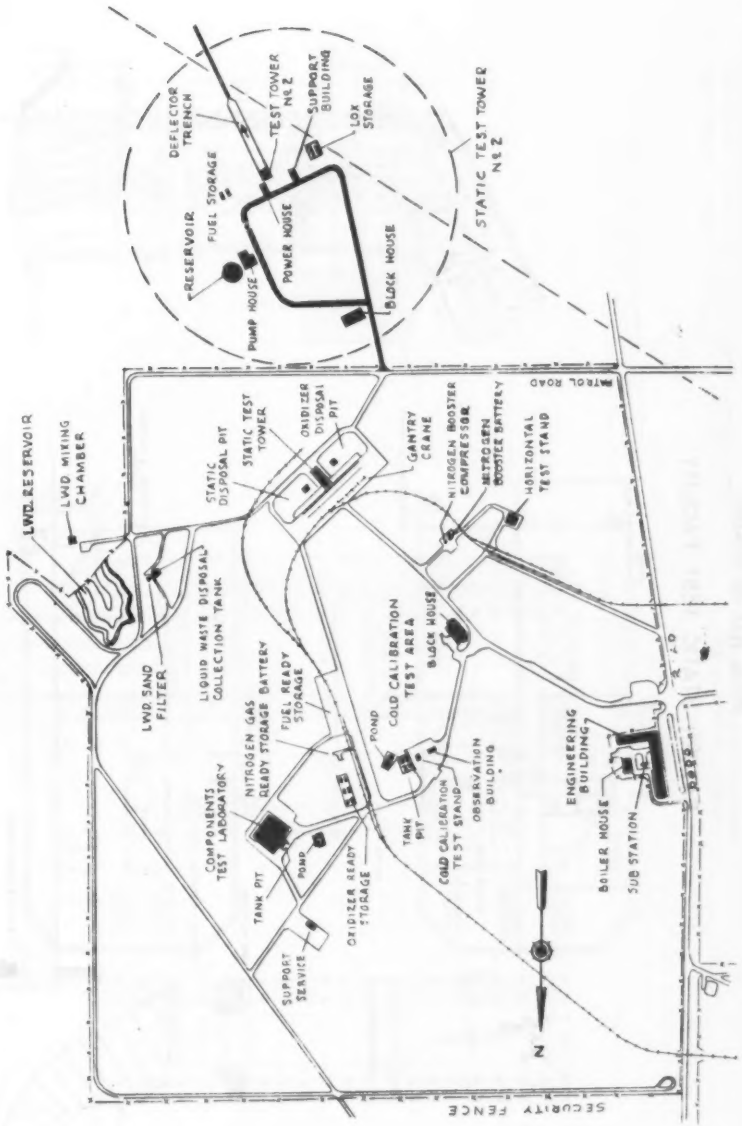
The construction and instrumentation of a tower is required to permit the captive testing of space vehicles in the general class of the first stage of the Saturn vehicle. The project includes all site improvements, utilities, support buildings, and equipment required to make the project fully useable, except for equipment that must be tailor-made to suit individual vehicles. The tower itself will consist of a heavy steel structure capable of carrying all vertical loads, both static and dynamic; and a light structure which will take horizontal loads from engine gimballing or from winds, which will support service and work platforms, and which will also carry a gantry crane with its system of tracks. Leading from the tower will be a shallow, concrete-lined trench which will drain the deflector cooling water to a holding pond, which, in turn, will discharge into the Huntsville Spring Creek. Immediately adjacent to the tower will be a two-story concrete building for terminating instrumentation and control cables and for housing special power generators and power switch panels. A cable tunnel will lead from the termination building to a new instrumentation and control blockhouse, which will also be connected to the existing blockhouse and instrumentation system through a bank of conduits. In the new blockhouse will be all control equipment, and consoles needed for the proposed tower and half the recorders needed for testing the Saturn first stage at the new tower with the remainder of the recording being down in the existing blockhouse. Space will be available to add additional instrumentation in the future.

Site work in the project will consist of access roads and railroads; general grading, hardstands, and area drainage; utilities including power lines, potable water mains, sanitary sewer lines and septic tanks; and a high pressure industrial water system. A reservoir and pumps for supplying deflector cooling and fire fighting water will be provided. Supporting facilities will include a small maintenance shop building; fuel and liquid oxygen storage tanks and piping systems; and high pressure nitrogen and air storage bottles and piping networks.

Sketches of the proposed facility are shown on the following three pages.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

SATURN STATIC TEST FACILITY



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NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

SATURN STATIC TEST FACILITY

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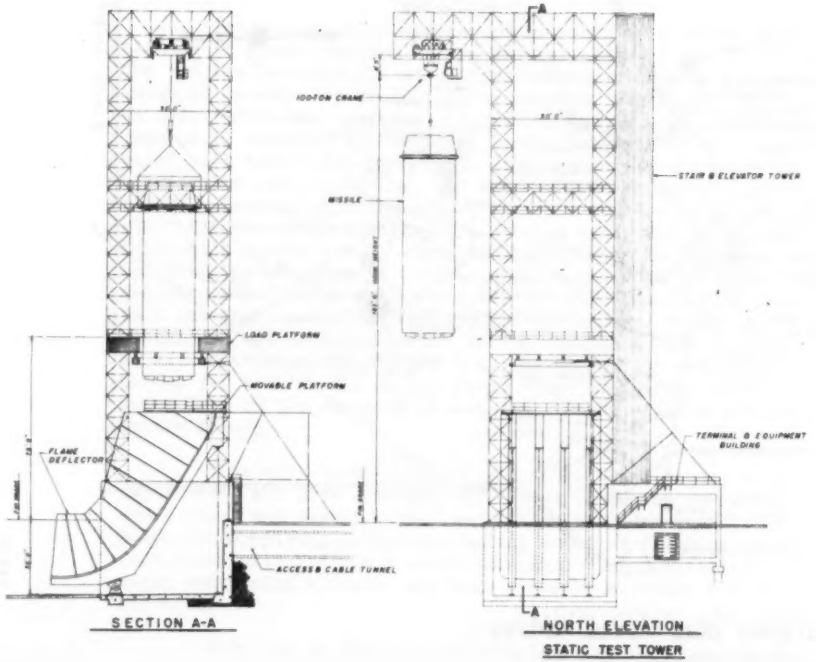
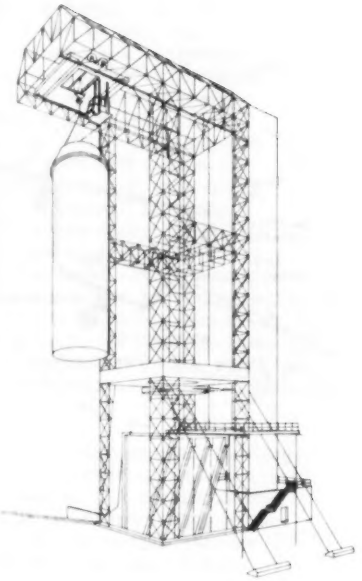
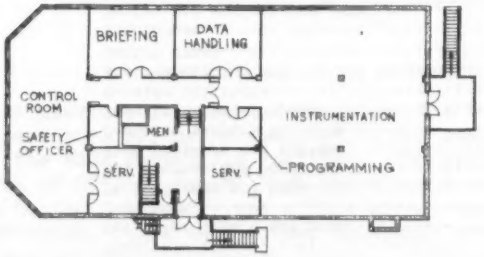


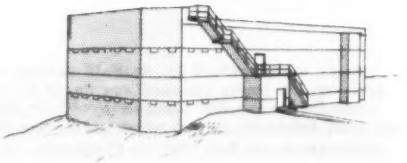


NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

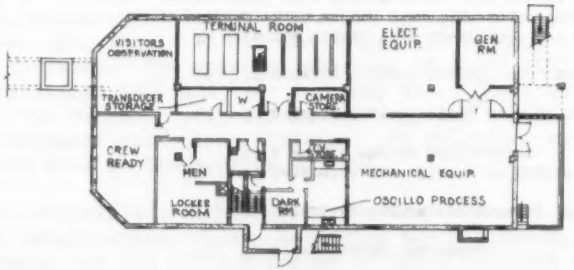
SATURN STATIC TEST FACILITY



SECOND FLOOR PLAN



BLOCKHOUSE



FIRST FLOOR PLAN

0 10 20 30 40 50 FEET

2. JUSTIFICATION:

This facility will be used to perform captive testing of the complete first stages of the Saturn space vehicle. Such testing is required:

(a) To prove design concepts.

(b) To establish engine operational limitations.

(c) To determine the effects on engine operation and efficiency of a single engine malfunction.

(d) To establish statistical data on reliability.

(e) To provide a final operational check on flight vehicles.

An existing static test tower does not have the capability of handling an accelerated flight program while at the same time conducting an extensive research and development program. The construction of a second stand will remove this conflict. Of perhaps greater importance than the operational advantages mentioned, is the back-up given the present stand in the case of a catastrophe. The additional stand will allow the Saturn program to proceed even if an explosion seriously damages the existing stand.

3. COST ESTIMATE:

Tower	$1,900,000
Deflector trench and pond	260,000
Site work	170,000
Fuel storage and handling	170,000
LOX storage and handling	450,000
High pressure gas system	330,000
Position support building	60,000
Industrial water system	370,000
Outside utilities	130,000
Instrumentation and control equipment	4,510,000
Gantry crane	440,000
Blockhouse	730,000
Design and engineering services	1,280,000
Total estimated cost	$10,800,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	30 months

Total estimated completion time..... 30 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

CENTRAL LABORATORY AND OFFICE FACILITY

1. **DESCRIPTION:**

This project provides for the construction of a combined laboratory and office building to house personnel of the aeroballistics and research projects laboratories plus staff personnel of the NASA Huntsville Facility. The proposed multi-story building will provide a gross area of 205,000 square feet and a net area of approximately 144,000 square feet. In addition to the laboratory and office areas, the facility will house a cafeteria, library, small auditorium, conference rooms, equipment rooms for specialized computing equipment, and heating and air-conditioning equipment. Drawings of the proposed construction are shown on the following page.

2. **JUSTIFICATION:**

The proposed transfer of the ABMA development operations division to NASA and the resultant agreements necessary to provide an equitable share of buildings to both the Army and the NASA, will result in extreme congestion in many areas of operation in the development operations division. The greatest shortage of space will occur as a result of the agreement to retain buildings 4488 and 4484 for Army use. These buildings now house the aeroballistics laboratory, the research projects laboratory, and staff offices of the missile firing laboratory and the development operations division. In addition, space must be provided for supporting personnel who will be transferred to NASA.

The aeroballistics laboratory performs research and development in the fields of theoretical aerodynamics, flight mechanics and vibration, flutter, and guidance theory to provide a basis for the optimum design of space vehicles and the optimization of trajectory and orbit calculations. In addition, the laboratory conducts analytical investing action of test flights, compiles and analizes meteorological data for application to vehicle design, and carries on applied supporting research in the fields of aeroballistics and related sciences.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

CENTRAL LABORATORY AND OFFICE FACILITY

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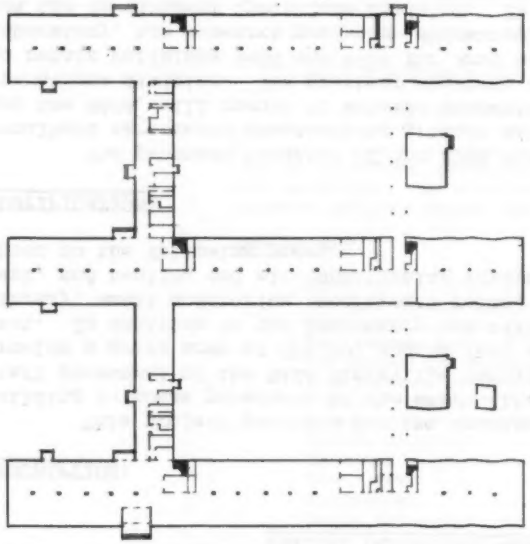
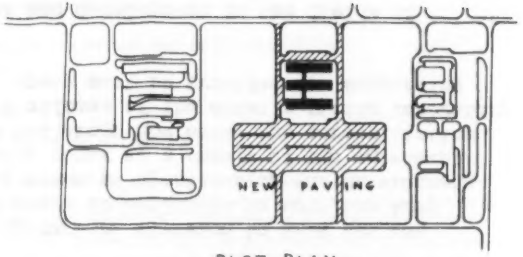
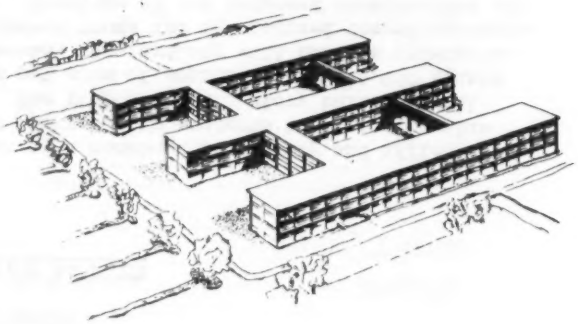


FIRST FLOOR PLAN
SCALE IN FEET
0 100 200



PLOT PLAN
SCALE IN FEET
0 400 800 1200



The research projects laboratory coordinates and supervises supporting research programs, provides scientific coordination for various special research projects, and conducts independent research in thermal design, nuclear power problems, and space physics. The missile firing laboratory has the responsibility for all NASA Huntsville Facility firings at Cape Canaveral. The office of the director of the missile firing laboratory and his staff are located at Huntsville. The office of the director of the NASA Huntsville Facility and supporting personnel provide supervision, and technical and administrative support to the ten laboratories of ABMA development operations division which will comprise the NASA Huntsville Facility. A total of 1,045 personnel will be housed in the building proposed for construction under this project.

3. COST ESTIMATE:

Site preparation	$20,000
Roadways and parking areas	110,000
Building (including heating and air conditioning)	3,485,000
Utilities	100,000
Communications	200,000
Collateral equipment	100,000
Design and engineering services	385,000
Total estimated cost	$4,400,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	20 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

DYNAMIC TEST FACILITY

1. DESCRIPTION:

This project provides for the construction of a facility at which the large, multi-stage Saturn vehicles may be assembled and subjected to various mechanical, structural, and operational tests. The facility will allow the checkout of mechanical mating features; the determination of the natural frequency of the missile, both on the launcher arms and under simulated flight conditions; the temperature effects caused by liquid oxygen or nitrogen when held for various lengths of time; and the effect of simulated flight vibrations on the various stages of the missile. There will be the capability for other tests involving wind effects, fueling techniques, ground crew training, and assembly methods sketches of the proposed facility are shown on the following two pages.

The facility will consist of two foundations capable of carrying the launcher arms and vehicle at the full flight weight. A steel superstructure will provide lateral support for the vehicle and working platforms at any point on the vehicle. The superstructure will also serve as a pedestal to support a stiff-leg derrick to be used for handling and placing the various stages. Structural members will be included to support the missile by long cables, allowing freedom in all directions, except the vertical, for vibrational studies. One of the foundations will be used for tests requiring numerous work platforms and will provide maximum support for the missile, with the other being used when minimum fixed enclosures are required. Access for personnel to upper platforms will be by stairs and an elevator.

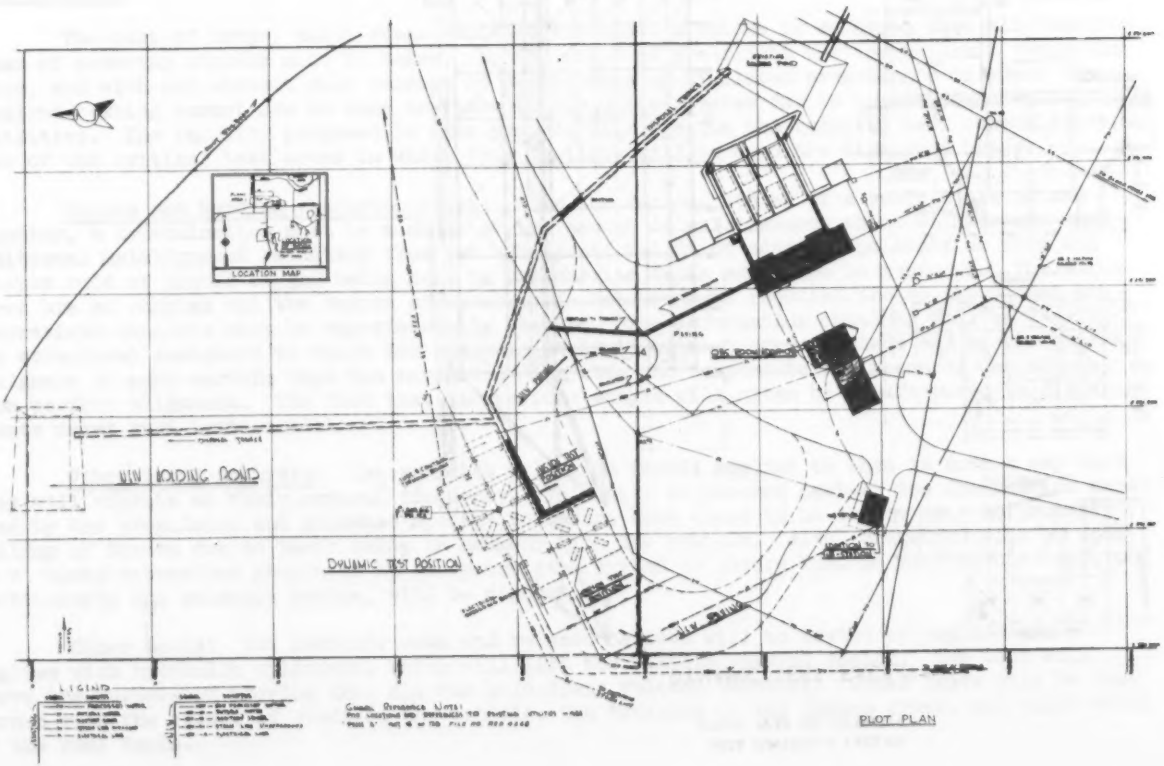
Means will be incorporated in the project for carrying spilled propellants to remote holding ponds to minimize fire hazards. Power, water, and other utilities will be provided as needed, as well as a road, hardstands, and other site improvements. On-stand housing and conduit for instrumentation and control and for connections to the existing systems are a part of this project. Actual recording of test data will be accomplished with equipment available in an existing blockhouse.

NASA HUNTSVILLE FACILITY

of this project. Actual recording of test data will be accomplished with equipment in an existing blockhouse.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

DYNAMIC TEST FACILITY



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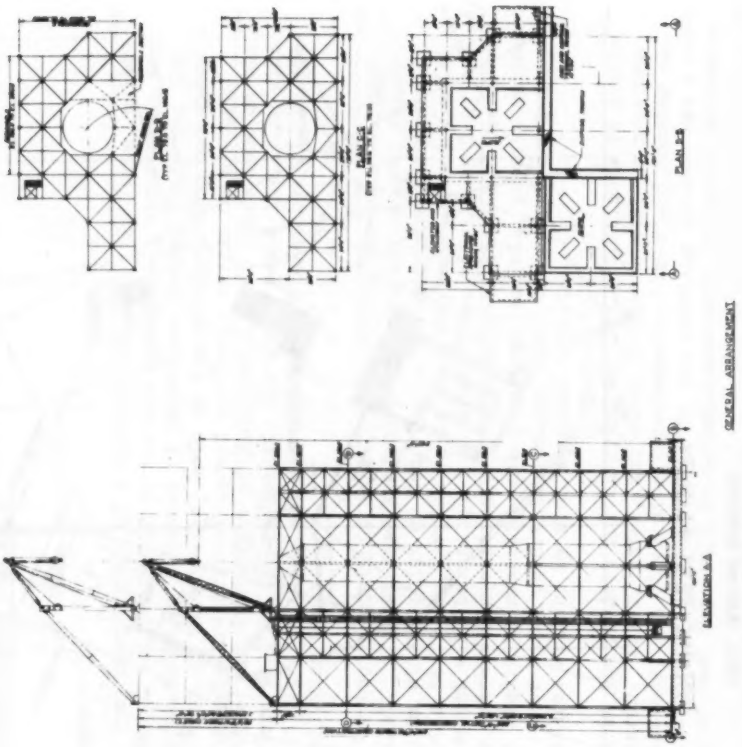
NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

DYNAMIC TEST FACILITY



E-778

2. JUSTIFICATION:

The cost of large, multi-stage vehicles for space missions is so great that all feasible means of assuring success must be taken. In the field of pre-flight testing with all stages in place, and with and without full cargoes of propellants or simulated propellants on board the required testing cannot now be done anywhere in the United States due to a lack of suitable facilities. The facility proposed in this project will provide the required test capabilities. Some of the critical test areas in which this facility will be used are discussed below:

Mating and bending characteristics: When the various stages of a vehicle are joined together, a determination must be made as to the amount of malaligmment which will occur. Any additional malalignment resulting from the additional weight of added propellants or from the intense cold of liquid oxygen being held in the missile tanks must also be measured. The structures are so complex and the degree of accuracy in measurements required are so great that any theoretical analysis must be experimentally checked. The information obtained will be used by the structural designers to check for adequate strength without excess weight and by the guidance designers to make certain that the navigational system can compensate for measured deviations from perfect alignment. The fact that the various stages will often be manufactured in different plants makes such tests mandatory.

Vibrational analysis: The vehicles will have forces applied to them in such a way that they will vibrate at their natural frequency. This will be checked against the frequencies generated by the propulsion and guidance systems to insure that there is no chance of a destructive buildup of forces due to their being in harmony with the vehicle. Also, vibrators will be used to s[illegible]ulate vibrations generated by the propulsion system to insure that no part of the vehicles, particularly the guidance system, will be damaged.

Other tests: The launcher arms and release devices will be tested by replacing the engines with hydraulic cylinders, which will lift the vehicle several inches. The test will serve the purpose of proving that all the hold-downs release together. Other tests will be concerned with the effect of winds on the vehicle, the training of the launch crews, and calibration of the fuel tanks.

3. COST ESTIMATE:

Site preparation	$6,900
Foundations	23,000
Tower	221,150
Crane	120,000
Elevator	34,500
Propellant disposal system	37,500
Paving	10,400
Instrumentation conduit	5,550
Utilities	61,000
Design and engineering services	80,000
Total estimated cost	$600,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	10 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

PRESSURE TEST CELL

1. DESCRIPTION:

This project provides for the construction and instrumentation of mechanical test facilities that will provide the capability for pressure testing the Saturn first-stage cluster, for inspecting component parts, and for the analysis of hydraulic oil and propellant and subsystem contamination. A sketch of the proposed construction is presented on the following page.

2. JUSTIFICATION:

There is no pressure test cell available at the NASA Huntsville Facility to accommodate the test requirements for the present Saturn program. The proposed facility is necessary to provide a safe and completely blast-proof area to perform mechanical, functional, and pressure testing of the Saturn booster assembly. The booster and its components will be tested in the cell for failure in strength, function, leakage, and timing. The pressure testing of the Saturn boosters cannot be accomplished within existing facilities without endangering the building structure and its occupants.

3. COST ESTIMATE:

Building	$475,500
Utilities and paving	2,000
Heating and air conditioning	50,000
Extension of existing monorail system	3,000
Laboratory exhaust system	4,500
High pressure, pneumatic, and hydraulic facilities	85,000
Relocation of high pressure bottle room	10,000
Design and engineering services	20,000
Total estimated cost	$650,000

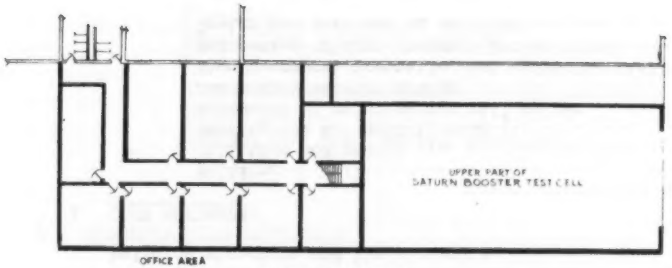
4. CONSTRUCTION TIME:

Total estimated completion time	12 months

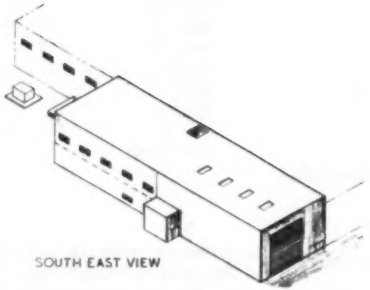
NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

PRESSURE CELL

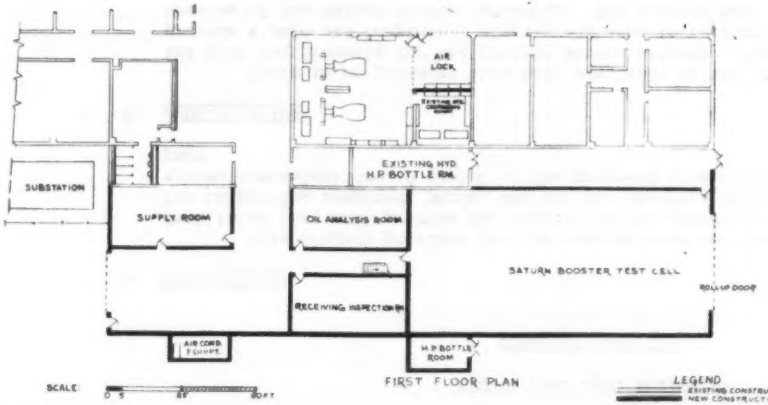
E-778



SECOND FLOOR PLAN

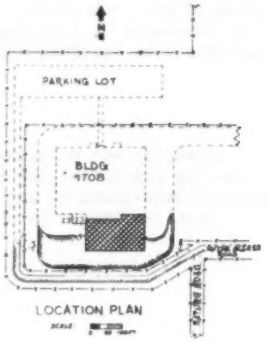


SOUTH EAST VIEW

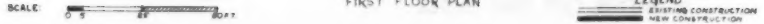


FIRST FLOOR PLAN

LEGEND
EXISTING CONSTRUCTION
NEW CONSTRUCTION



LOCATION PLAN



MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

EXTENSION TO ASSEMBLY BUILDING

1. DESCRIPTION:

It is proposed to construct and equip an addition to missile assembly Buildings 4705 and 4706 to supplement existing missile assembly facilities. Space and facilities will be provided for test and quality control of sub-assembly and assembly work. A sketch of the proposed work is shown on the following page. The addition will provide:

(a) 55,000 square feet of additional space for general assembly work, including an extension of the existing bridge crane systems and the provision of necessary optical and supporting equipment.

(b) 6,000 square feet of additional space for pressure tests of sub-assembly components, including provisions for high presssure air.

(c) 3,500 square feet of additional area for cleaning large fuel suction lines of the Saturn first stage booster, including required equipment for de-humidifing and dust freeing the area, water and air treatment, and general cleaning equipment.

(d) 12,100 square feet of additional space for production engineering, equipment, storage, and administration.

2. JUSTIFICATION:

Existing assembly facilities were not planned or designed for the development of vehicles approximating the diameters and lengths of the Saturn and future space vehicles. Space and facilities for the development and fabrication of Saturn components is being provided by minor modifications to existing shops and by the shifting of equipment between those shops.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

EXTENSION TO ASSEMBLY BUILDING

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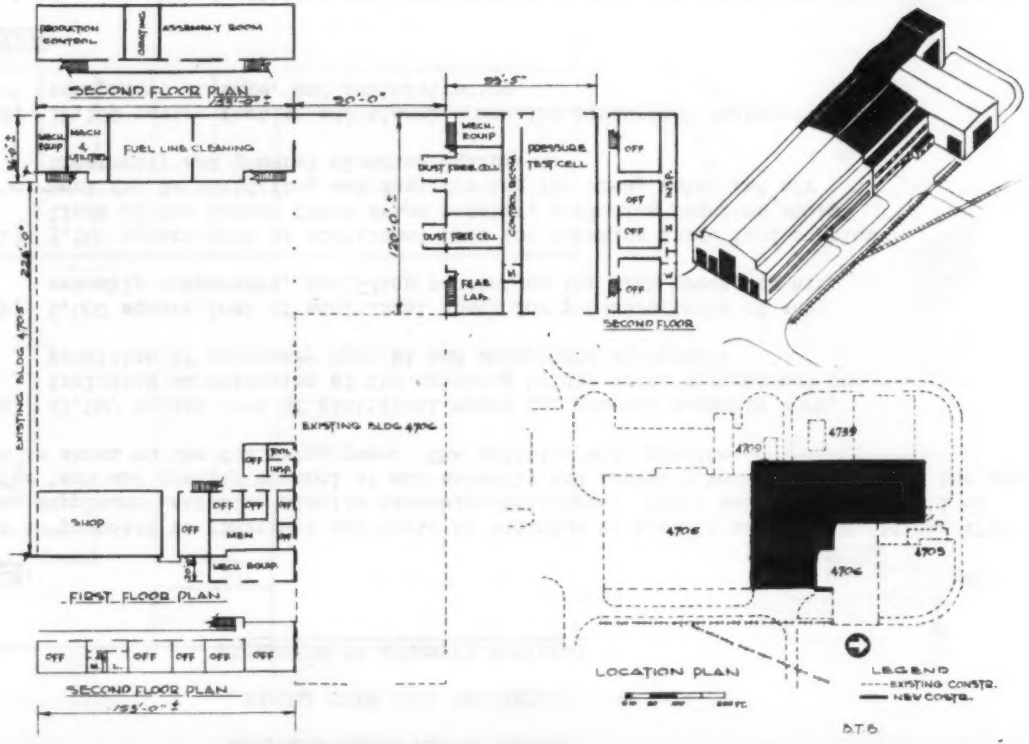

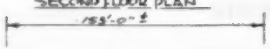

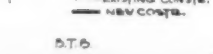

However, the need for adequate floor space for assembly and for vehicle alignment, cannot be met without the construction of additional space. The Saturn production schedule will require space for the assembly of several first stage clustered boosters simultaneously.

In addition to providing the necessary floor space for final assembly the proposed addition will provide dust free, humidity controlled cleaning areas; quality control high pressure test facilities including required office space and facilities for other inspection work; and space for sub-assembly including vehicle wiring and engine build-up.

3. COST ESTIMATE:

Building	$1,700,000
Utilities and paving	50,000
Optical equipment and assembly support equipment	100,000
Cranes	150,000
Fuel suction line cleaning equipment	200,000
Pressure test equipment and instrumentation	100,000
Design and engineering services	200,000
Total estimated cost	$2,500,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	16 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

ADDITION TO ENGINEERING BUILDING

1. DESCRIPTION:

It is proposed to construct an addition to the engineering building of the structures and mechanics laboratory. As indicated in the drawings on the following three pages, the proposed facility will include an 80- by 10-foot connection to Building 4610 at the second and third floor levels and the construction of a six story 80- by 100-foot engineering building. The existing facility plus the addition proposed in this project will house a total of approximately 600 personnel.

2. JUSTIFICATION:

The mission of the structures and mechanics laboratory is to conduct research and development activities in the fields of structures, mechanics, propulsion, chemistry, and materials as related to all types of space programs. Some of the key elements in the mission include:

Feasibility and design studies, and analytical investigations in the preparation of technical proposals for future spaceflight systems.

Analytical and experimental research, development, and design of structural components and complete airframes of satellites and space vehicles.

Research and development in the fields of propulsion and mechanics as related to space vehicles, including:

(a) Design of propulsion systems, propellant feed systems, cooling systems, mechanical assemblies, and components.

(2) Design of propulsion systems, propellant feed systems, cooling systems, mechanical assemblies, and components.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

ADDITION TO ENGINEERING BUILDING

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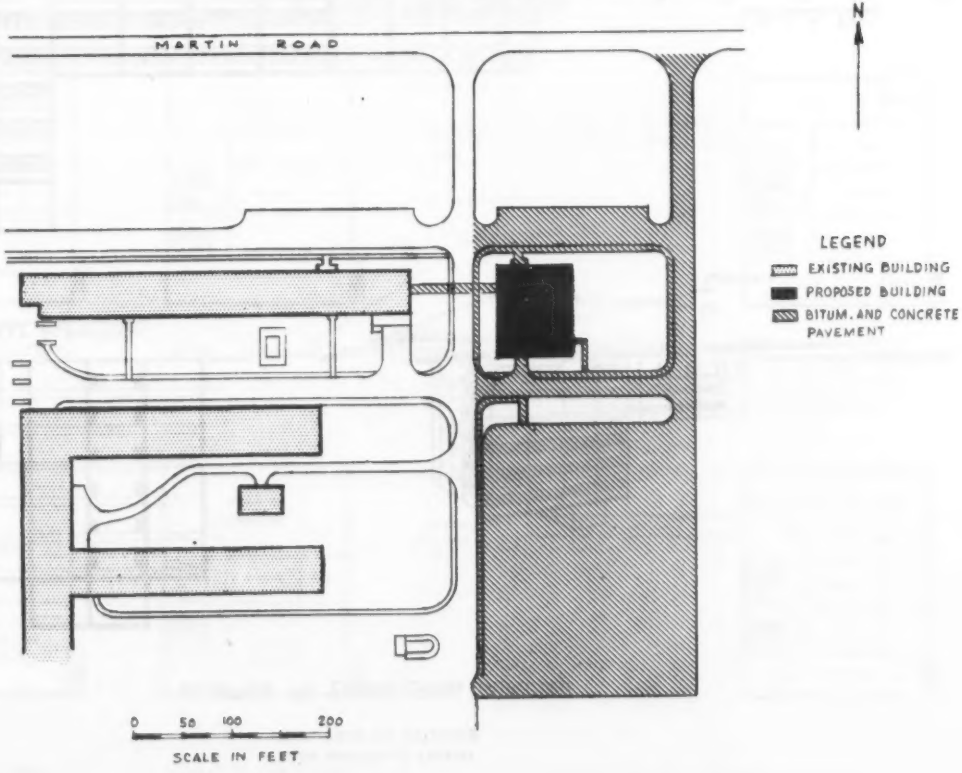

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

ADDITION TO ENGINEERING BUILDING

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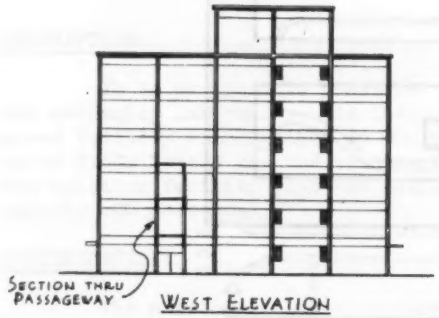
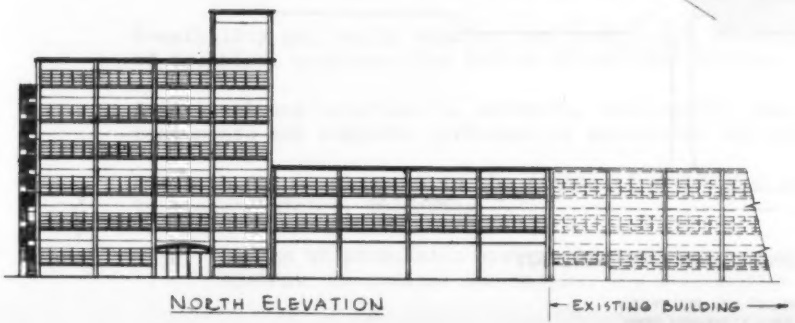
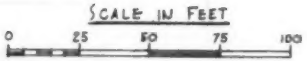
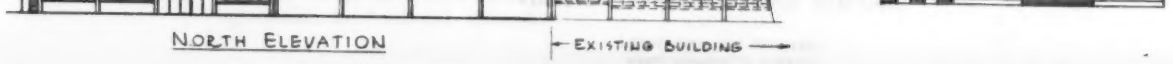




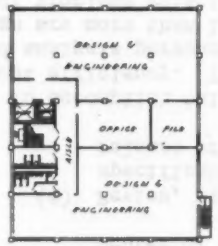


NASA HUNTSVILLE FACILITY

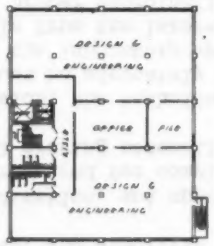


NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

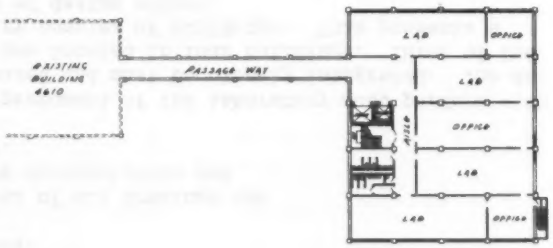
ADDITION TO ENGINEERING BUILDING



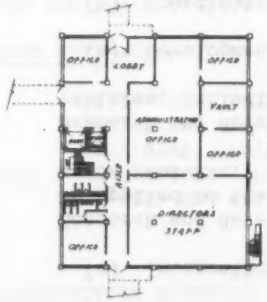
FIFTH FLOOR PLAN



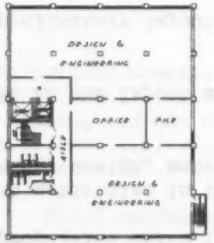
SIXTH FLOOR PLAN



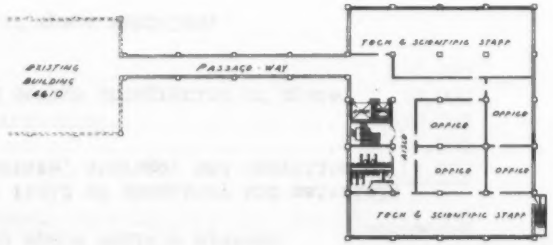
THIRD FLOOR PLAN



FIRST FLOOR PLAN



FOURTH FLOOR PLAN



SECOND FLOOR PLAN

(b) Methods and systems for protection of the space vehicle system from aerodynamic heating.

(c) Integration of propulsion units into space vehicle systems.

Research and development activities in the field of chemistry and materials as applied to the planning, design, manufacture, storage, and operation of space vehicles.

Research and development in the layout and design integration of space vehicles, including:

(a) Development of preliminary layouts of space vehicles.

(b) Coordination of design activity and integration of design requirements of structures, aerodynamics, guidance and control, and launching and handling equipment.

(c) Analysis of weight, moment of inertia, product of inertia, center of gravity, and stability axes.

(d) Review, standardization, and approval of all drawings and specifications required for complete documentation and release of final drawing assemblies.

To accomplish this mission, the technical personnel of the laboratory must perform with the utmost efficiency. They must be adequately housed and must be closely integrated. The design and analysis personnel of the laboratory are now located in four buildings. Three of the buildings are more than 1/2 mile from the laboratory complex of buildings. This presents a number of problems relating to proper coordination of design effort.

The main engineering building of the laboratory now provides 32,000 useable square feet of floor space. There are 602 personnel in this building and three outlying buildings who must be brought into the laboratory complex to function efficiently. There is not adequate room in the existing building to accommodate this number of people. Based on the maximum utilization

be brought into the laboratory complex to function efficiently. There is not adequate room in the existing building to accommodate this number of people. Based on the maximum utilization

of useable floor area the total floor space required is approximately 71,000 square feet. This project will provide an additional 39,000 square feet of net useable area. Upon completion of the proposed addition, the staff of the structures and mechanics laboratory will have available an average of less than 120 square feet per person which is considered minimal for the types of personnel to be housed.

3. COST ESTIMATE:

Site work, roads, and parking areas	$70,000
Utilities and communications	59,000
Building, including heating and air conditioning	850,000
Collateral equipment	45,000
Design and engineering services	113,000
Total estimated cost	$1,137,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion	15 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

COMPLETION OF GUIDANCE AND CONTROL BUILDING

1. **DESCRIPTION:**

It is proposed to construct two separate structures adjacent to and near the existing building No. 4487 as indicated in the drawing on the following page. The main structure will consist of an east extension approximately fifty (50) feet by five hundred (500) feet, two floors high, and a south extension approximately thirty (30) feet by one hundred forty (140) feet, one floor high. The second structure will have an irregular shaped plan and will include a two story plus basement area for a constant azimuth centrifuge, a two story control room, and an eight-five (85) foot high enclosure for an expanded range linear accelerator. Special, closely controlled, air-conditioning will be provided for some environmental test areas. The proposed project which will provide approximately sixty-one thousand (61,000) square feet of floor area, will include the following:

(a) Additional laboratories for investigation, research, and development in the fields of inertial, radio, midcourse and terminal guidance. Advanced work is necessary in guidance computers, component evaluation, theory evaluation, and application of present principles of micro-miniaturization.

(b) Laboratories for infrared, optics and photosensitivity research involving spatial attitude and horizon or light seeking and sensing devices for lunar probes and satellites. In addition to the optical phases of this item, research also must be conducted in the physical relationship and performance of components under simulated spatial attitude conditions.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

COMPLETION OF GUIDANCE AND CONTROL BUILDING

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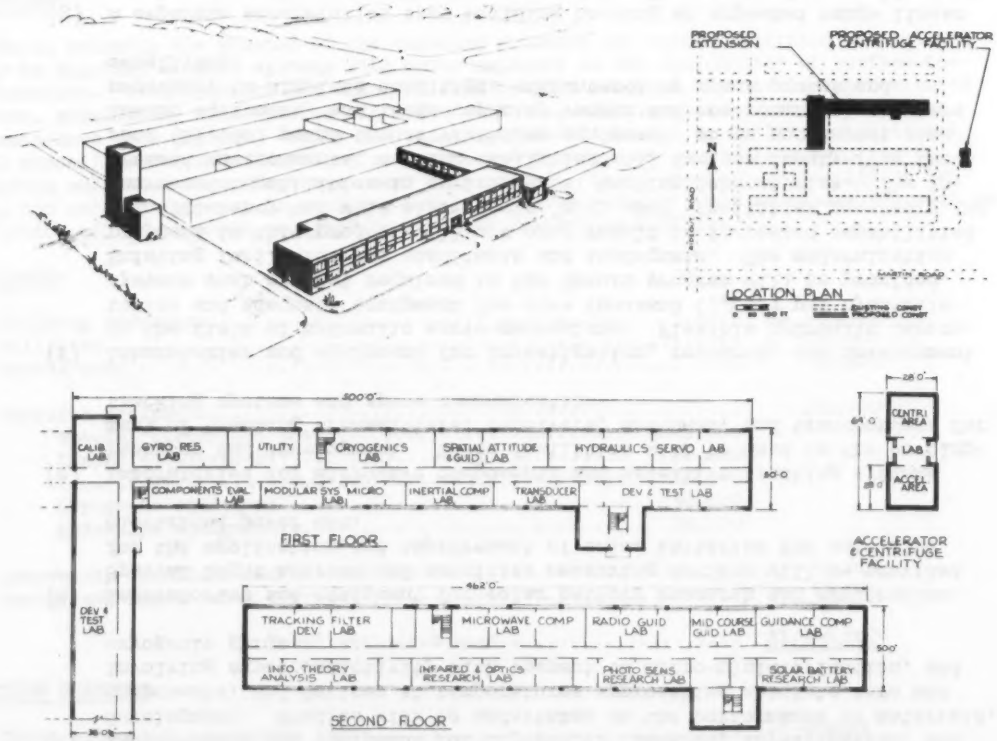

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(c) Laboratories and equipment for cryogenics research, investigation, and development. Studies will be undertaken on the performance of materials, components, and devices at temperatures approaching absolute zero and involving superconductivity with respect to micro-miniaturization, and cryogenic gyros.

(d) Laboratories and equipment for solar battery research and application. Special light sources and sensitive measuring devices will be provided for the application and improvement of solar batteries for satellite electrical power use.

(e) Laboratories for microwave components and satellite tracking systems research and development. These facilities will be used in the development of tracking transmitters, receivers, antennas, and transponders for tracking systems and space communications.

(f) Laboratories and equipment for investigation, research, and development in the field of hydraulic servo-mechanisms. Flexible hydraulic laboratories and adequate equipment for five thousand (5,000) psi hydraulic systems such as that required in the Saturn program will be provided. Existing facilities are unsuitable and inadequate. The modernization proposed in this project will not only result in increased capabilities and efficiency but will also vacate "high roof" facilities necessary for increased capabilities in environmental testing laboratories. The increased environmental testing facilities will include twenty-five thousand (25,000) pound thrust vibration equipment, shock and impact simulation equipment, and large capacity vacuum and environmental chambers necessary to simulate conditions encountered by space probes and satellites.

(g) A separate acceleration test building housing an expanded range linear accelerator and a centrifugal accelerator. The expanded range linear accelerator is a device using a pneumatic method as a working principle and having cycling operation. It will provide the means to subject sensitive components to the influence of linear acceleration. The

proposed device will greatly extend the range of linear acceleration

and having cycling operation. It will provide the means to subject sensitive components to the influence of linear acceleration. The proposed device will greatly extend the range of linear acceleration tests with respect to peak acceleration, time of constant peak acceleration, and payload weight.

2. JUSTIFICATION:

Until recently the mission of the existing guidance and control building was related primarily to military weapons systems with major emphasis on the reliability of surface-to-surface vehicles. With missions now being shifted to pure research and development oriented to payloads, satellites, lunar probes and space vehicles, additional research criteria and requirements have been created. While all existing facilities will be utilized, additional technical capability for investigation, research, and development on problems peculiar to objects being subjected to space travel must be provided. These specialized facilities are required, not only for economy in avoiding trial and error research, but to assure the successful completion of the programs assigned to the NASA Huntsville Facility.

3. COST ESTIMATE:

Building structure		$1,346,000
Utilities		106,000
Access road		10,000
Research equipment		393,000
Special electrical power	$129,000	
Linear accelerator	98,000	
Centrifuge	104,000	
Cryogenic equipment	40,000	
Hydraulic equipment	22,000	
Laboratory furniture and accessories		31,000
Design and engineering services		62,000
Total estimated cost		$1,948,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	18 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

ADDITION TO FABRICATION LABORATORY

1. DESCRIPTION:

This project covers the construction of an addition to the existing fabrication laboratory building No. 4712. The addition will be a new wing running north and south between existing wings, as indicated in the drawing on the following page. The addition will be used for engineering and management operations, and will relieve congestion in all operations in the existing building including tool engineering, manufacturing engineering, electrical engineering, facility and plant layout engineering, master scheduling, equipment design, process engineering, fabrication planning, management and administrative operations, and related activities. The new construction will provide approximately 9,000 square feet of operating space.

2. JUSTIFICATION:

The existing fabrication laboratory is overcrowded to the extent that all activities within the building are adversely affected. The existing facilities are entirely inadequate for management and engineering operations. A portion of the entrance lobby has been enclosed, and is now occupied as an engineering office. The engineering staff is working in cramped quarters, that is not condusive to effective creative results. Units of branches are housed in buildings at considerable distance from the present building. This results in adverse working conditions, with resulting difficult and inefficient functioning of liaison and coordination activities.

Construction of the addition proposed in this project is essential to relieve the present over crowding, and to increase the operating efficiency of the laboratory. The Saturn development program has increased the general engineering and planning work load in this laboratory and as the program progresses the requirement for the proposed addition becomes more acute.

oratory and as the program progresses the requirement for the proposed addition becomes more acute.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

ADDITION TO FABRICATION LABORATORY

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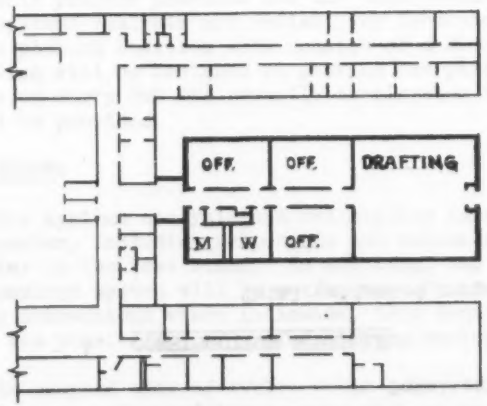
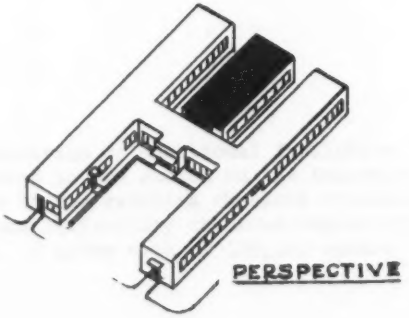
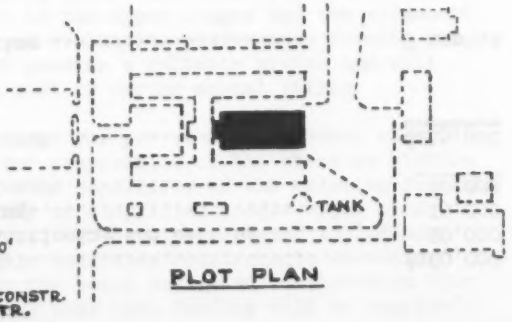


FLOOR PLAN



PERSPECTIVE



PLOT PLAN

3. COST ESTIMATE:

Building	$160,000
Utilities, including air conditioning and heating	20,000
Landscaping, walks, and paving	15,000
Design and engineering services	20,000
Total estimated cost	$215,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	9 months

MARSHALL SPACE FLIGHT CENTER

FISCAL YEAR 1961 ESTIMATES

ADDITION TO CHECKOUT BUILDING

1. DESCRIPTION:

This project provides for the construction and instrumentation of additional facilities for the systems analysis and reliability laboratory. As indicated in the sketch on the following page, the planned addition will consist of a 200 foot extension to the existing checkout building. The addition will be designed to provide the performance test and reliability checkout capability necessary to carry out the recently accelerated Saturn program. A gross area of 110,000 square feet will be provided.

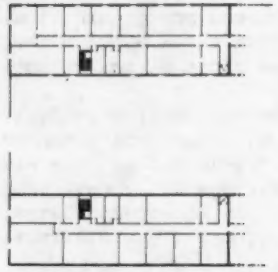
2. JUSTIFICATION:

The systems analysis and reliability laboratory will perform a complete checkout of the Saturn booster, including components and sub-assemblies both before and after static testing of the booster in the test stand. In addition, the checkout of the upper stages and the alignment of the complete system will be performed. By measuring and evaluating performance results and by making corrections where indicated, this function will provide a reliable system and will minimize the possibility of malfunctioning during static test or during actual firing.

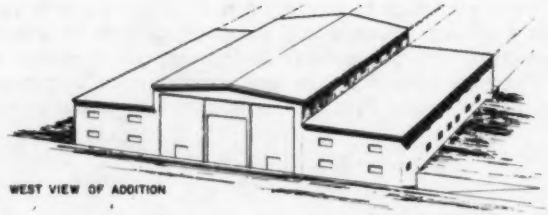
An elapsed time of twelve weeks each will be required for pre-static and final checkout. In addition, an estimated three weeks will be necessary for preparation of the checkout station to accomplish changes to ground and measuring equipment. The capability of the existing facility is not more than two Saturn vehicles per year, with a dummy or simplified single upper stage. The proposed facility will provide a checkout capability of four Saturns per year including presently planned upper stages. Since the present schedule indicates requirements exceeding existing capability early in calendar year 1962 and since the total estimated construction time of the proposed facility is approximately 26 months, fiscal year 1961 funding will be required.

NASA HUNTSVILLE FACILITY
FISCAL YEAR 1961 ESTIMATES

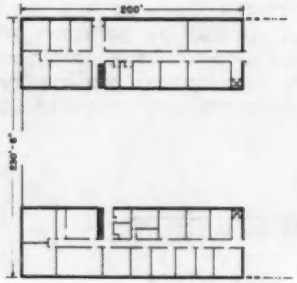
ADDITION TO CHECKOUT BUILDING



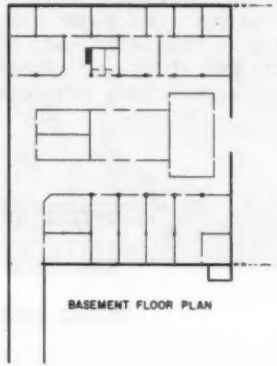
SECOND FLOOR PLAN



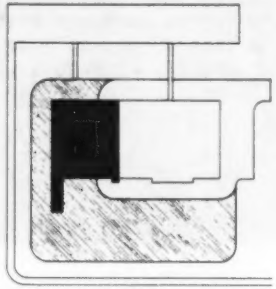
WEST VIEW OF ADDITION



FIRST FLOOR PLAN



BASEMENT FLOOR PLAN



WEST ADDITION
TO BLDG 4708
PLOT PLAN

3. COST ESTIMATE:

Building		$2,900,000
Heating and air conditioning		127,500
Utilities, including communications		172,000
Site preparation and paving		108,000
Cranes and elevators		97,500
Instrumentation		745,000
Data processing equipment	$240,000	
Record processing equipment	40,000	
Laboratory standards	75,000	
Aircraft energizers	108,000	
Cycle alternators	60,000	
Static power supplies	48,000	
Cycle inverters	45,000	
Generators	75,000	
Storage battery cells	54,000	
Design and engineering services		350,000
Total estimated cost		$4,500,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	26 months

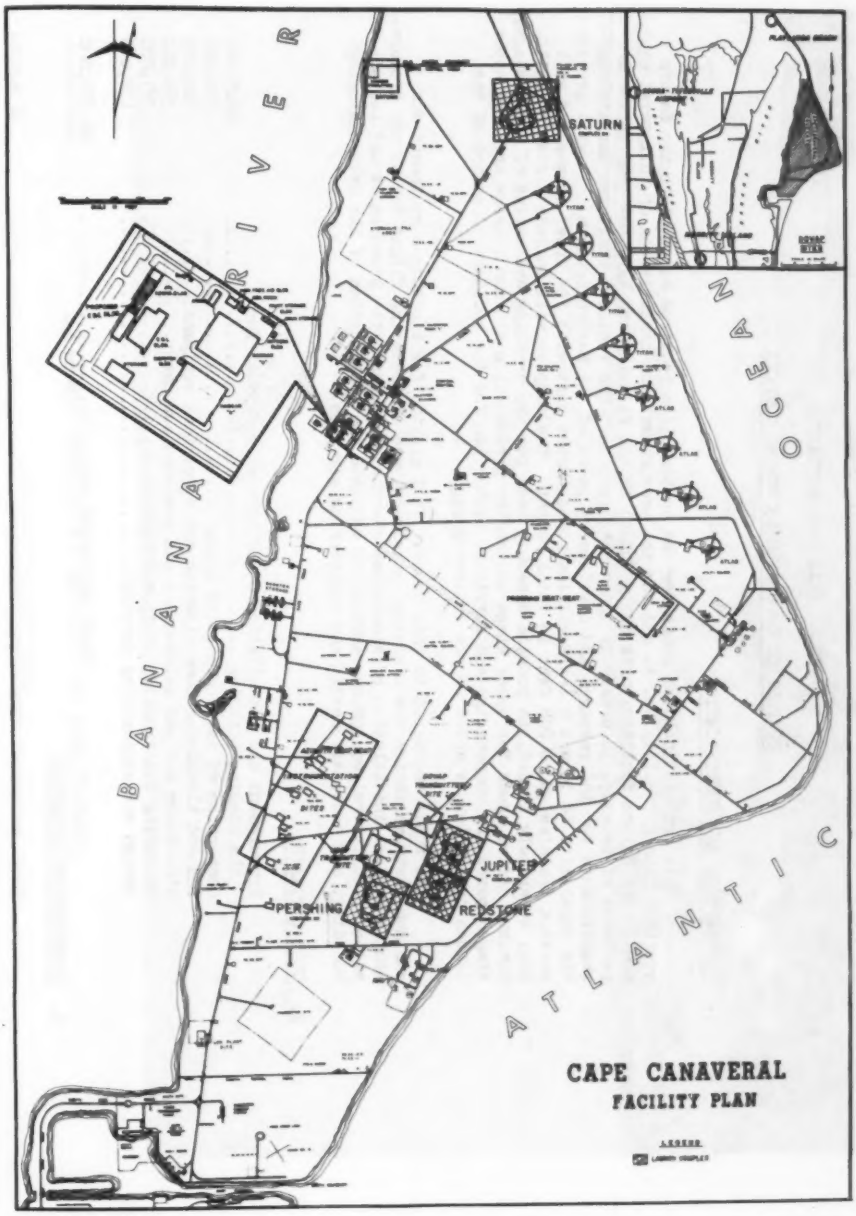
Mr. HORNER. I will also mention, then, that, in addition to the actual development work, the Huntsville facility has a responsibility for operation of these vehicles. Most of those operations will be carried out at the Atlantic Missile Range. In this budget there is also a requirement for new facilities at the Atlantic Missile Range at Cape Canaveral to the extent of $27,750,000. The details of the justification for that are on pages 412 through 418, and I would suggest those pages be added to the record.

Senator STENNIS. You are quoting from your justification sheets?

Mr. HORNER. Yes.

Senator STENNIS. Without objection, those sheets will be included in the record.

(The material above referred to is as follows:)


BANANA RIVER
ATLANTIC OCEAN
SATURN
JUPITER
REDSTONE
PERSHING
CAPE CANAVERAL
FACILITY PLAN

ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

COMPLETION OF SATURN LAUNCHING COMPLEX

1. DESCRIPTION AND JUSTIFICATION:

This project includes funds for the construction required to complete the Saturn vertical launch facility No. 34 and for the procurement and installation of collateral equipment. The Saturn facility, originally funded in the fiscal years 1959 and 1960 by the Department of Defense, is presently under construction. The facility will meet the minimum requirements for the research and development phase of the Saturn program. It will provide the capability to launch a 1-1/2-million pound thrust unit with its upper stages and will service vehicles up to 208 feet in total height. The complex will include a staging building, separately funded, to provide assembly area for the handling and mating of upper stages; minimum office space for upper stage contractor personnel; a minimum storage area for upper stage spares and components; and hurricane protection for the booster. A sketch of the launching complex is shown on the following page.

The funds requested in this project will provide for blockhouse equipment and minimum instrumentation for tracking, measuring, and telemetering flight tests; the procurement and final installation of blockhouse checkout equipment; the procurement and installation of collateral equipment required to complete the construction of the Saturn staging building, and necessary design and engineering services.

2. COST ESTIMATE:

Procurement and installation of collateral equipment for the staging building	$525,000
Completion of instrumentation sites	100,000
Pad and blockhouse communication and electrical equipment	328,000
Blockhouse and pad maintenance and checkout equipment	360,000
Measuring and tracking equipment equipment	787,000
Design and engineering services	150,000
Total estimated cost	$2,250,000

3. CONSTRUCTION SCHEDULE:

Total estimated completion time	12 months

Total estimated completion time..... 12 months

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

COMPLETION OF SATURN LAUNCHING COMPLEX

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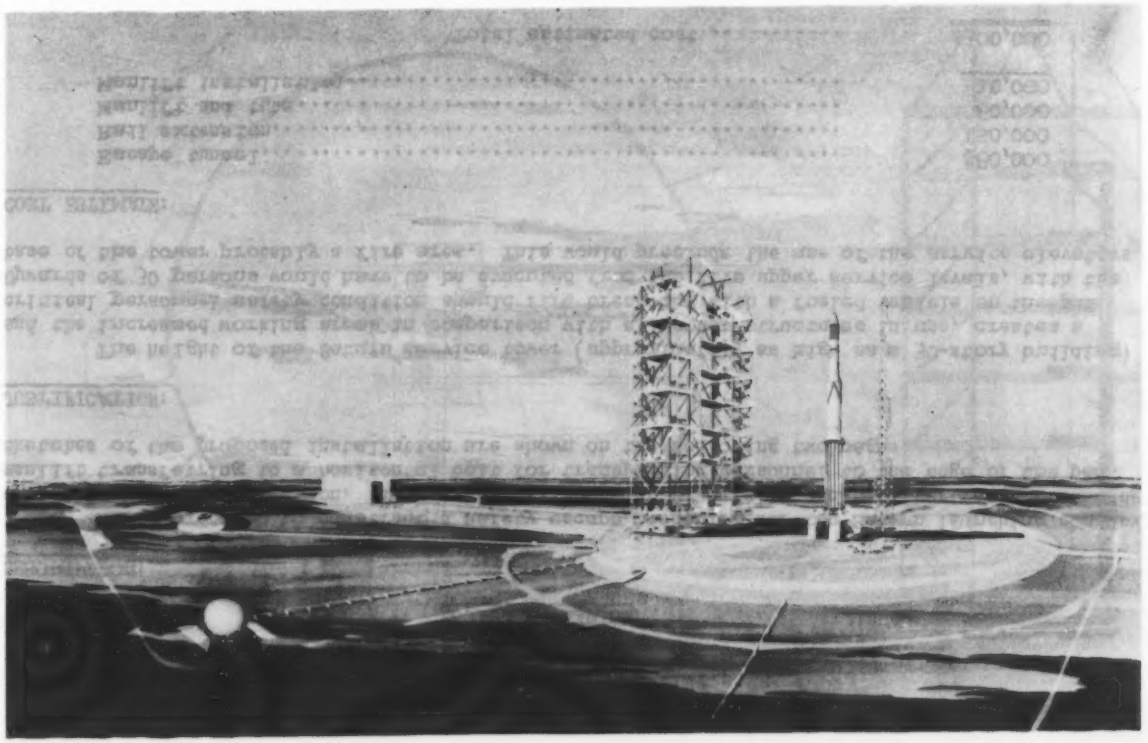


ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

ESCAPE MECHANISM

1. DESCRIPTION:

It is proposed to construct a safety escape mechanism for the Saturn launching complex currently under construction. The system will consist of a fully enclosed vertical descending manlift transferring to a horizontal belt for transporting personnel to the edge of the pad. Sketches of the proposed installation are shown on the following two pages.

2. JUSTIFICATION:

The height of the Saturn service tower (approximately as high as a 30-story building) and the increased working areas in comparison with all other structures in use, creates a critical personnel safety condition should fire break out with a fueled vehicle on the pad. Upwards of 30 persons would have to be evacuted from the five upper service levels, with the base of the tower probably a fire area. This would preclude the use of the service elevators.

3. COST ESTIMATE:

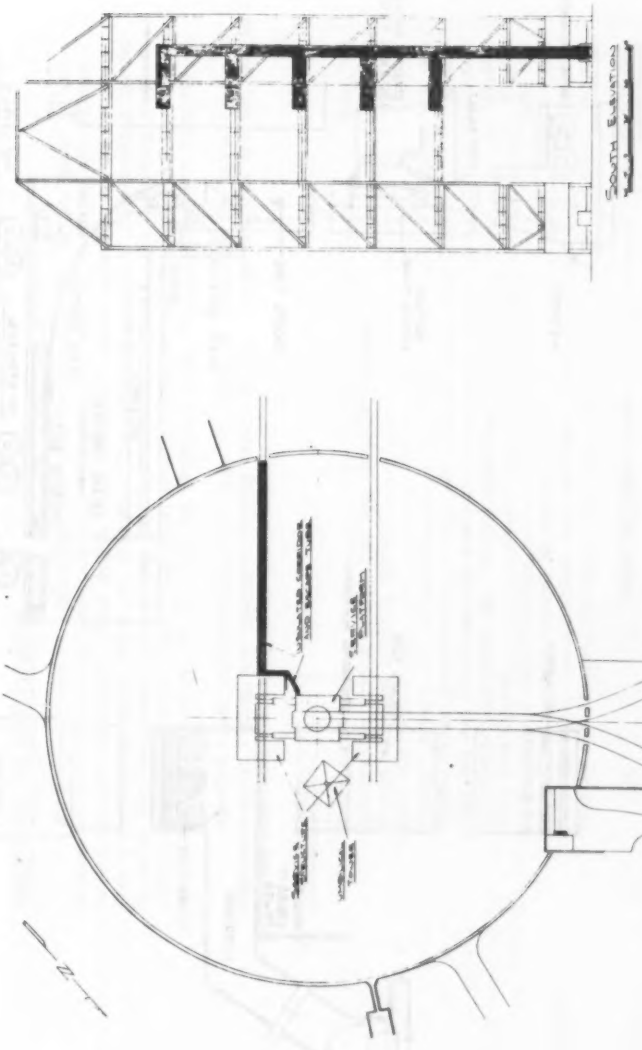
Escape tunnel	$80,000
Rail extension	150,000
Manlift and tube	60,000
Manlift installation	10,000
Total estimated cost	$300,000

4. CONSTRUCTION SCHEDULE:

Total estimated completion time	18 months

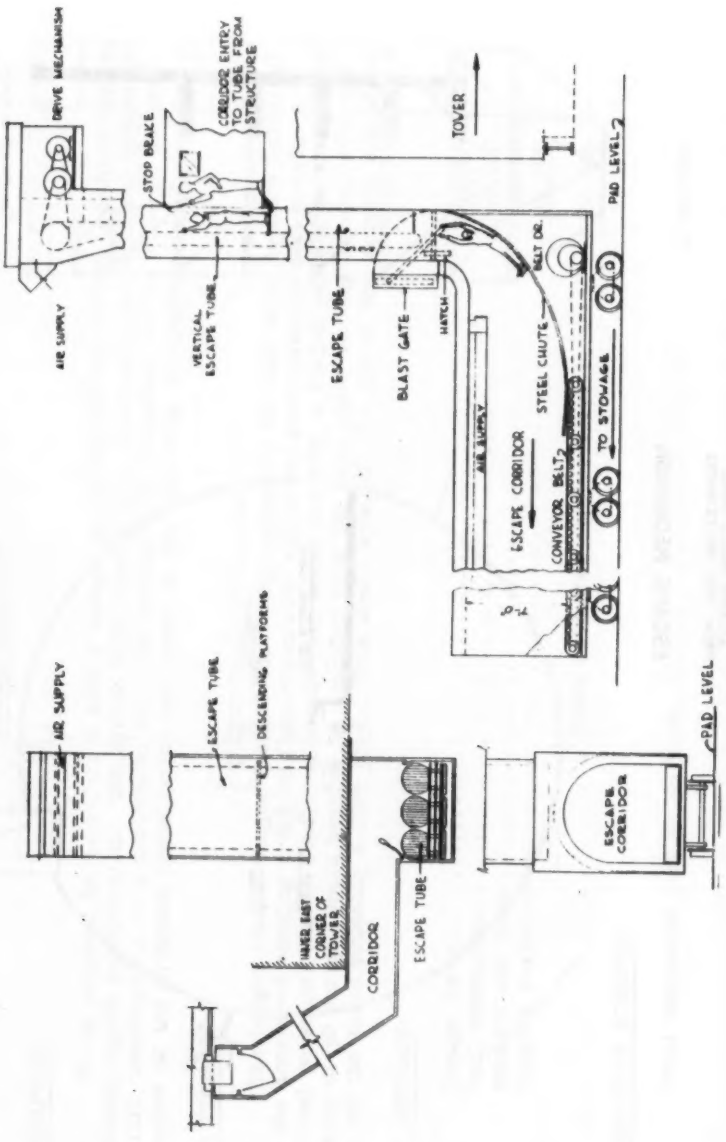
ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

ESCAPE MECHANISM



ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

ESCAPE MECHANISM



ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

HYDROGEN SYSTEM

1. DESCRIPTION AND JUSTIFICATION:

Large quantities of liquid hydrogen will be required for Saturn upper stages. Because of its low boiling point and high flammability, special handling and storage techniques are necessary. Tank trucks will transport liquid hydrogen to the launch site from a generating plant 160 miles distant. The need for a closed cycle loading system dictates the requirement for storage and transfer facilities at the launching complex currently under construction. Explosion proof wiring, vacuum insulation of the storage tanks, and remote control of the fueling operation from the blockhouse are required.

Service tower modifications will also be required including the installation of explosion-proof wiring and hydrogen venting capabilities. These features are not included in the structure currently under construction.

2. COST ESTIMATE:

Hydrogen storage	$440,000
Evaporation system and helium heat transfer system	176,000
Liquid nitrogen cooling system	296,000
Fuel and vent lines	484,000
Vacuum systems	304,000
Oxygen trace indicator	39,000
Computer and local control station	110,000
Blockhouse indicator and control station	139,000
Site development	87,000
Service tower modifications	$182,000
Valve fittings and control apparatus	63,000
First H_2 fill, installation, and testing	120,000
Venting and disposal system	60,000
Total estimated cost	$2,500,000

3. CONSTRUCTION SCHEDULE:

Total estimated completion time	18 months

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ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

NEW SATURN LAUNCHING COMPLEX

1. DESCRIPTION:

This project provides for the construction of a second, completely independent, Saturn launching complex at the Atlantic Missile Range. The proposed new complex will provide a back-up for the facilities presently under construction and a capability for increased firing rates. The proposed location for the new complex is north of the Saturn complex now under construction. Plot plans and sketches of the facilities proposed for construction under this project are shown on the following five pages.

Blockhouse: The blockhouse will be a concrete igloo-type structure for the protection of personnel and instrumentation during test firings. The dome will be constructed of reinforced concrete five feet thick covered with seven feet of fill dirt and an additional four inches of concrete to provide protection against extremely high blast pressures. Visual observation will be provided by two periscopes, protruding from the top of the dome.

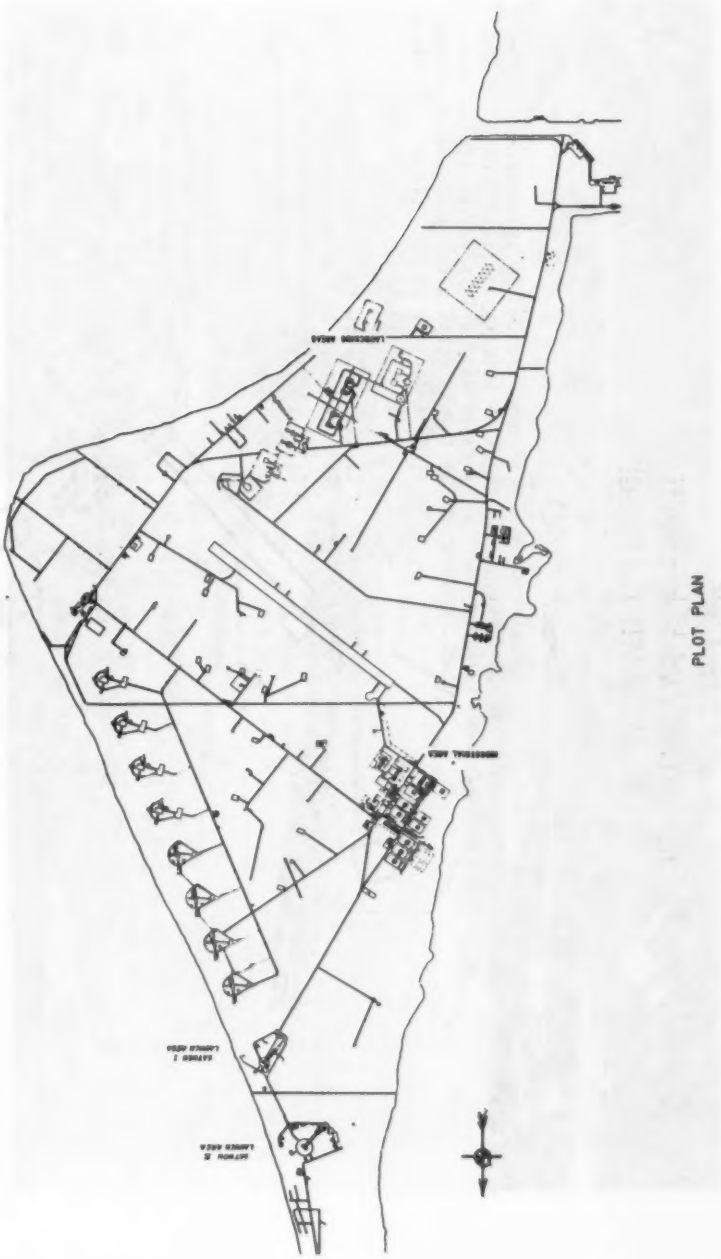
Launch service structure: The service structure will provide a means of erecting the missile on the launch pedestal in stages. It contains platforms for servicing and checking out the stages prior to launch. The service structure will be approximately the height of a 30-story building. It will be retractable to a rear parking area during firings. The bridge cranes will lift and position any of the stages of the Saturn vehicle. In the lower two floors of the structure, enclosed space will be provided for instrumentation and checkout of the missile.

Umbilical tower: The umbilical tower will carry fuel lines and power to the missile during checkout and pre-launch phases. Shortly before launching, the fuel and power lines will be disconnected and the umbilical arms swung out of the way of the vehicle's path.

Pad and area development: This item includes clearing and preparing the area for facilities installation; the construction of concrete work in the pad area, including the launch pad and pedestal, sub-pad rooms to house special instrumentation, revetments for the protection of

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

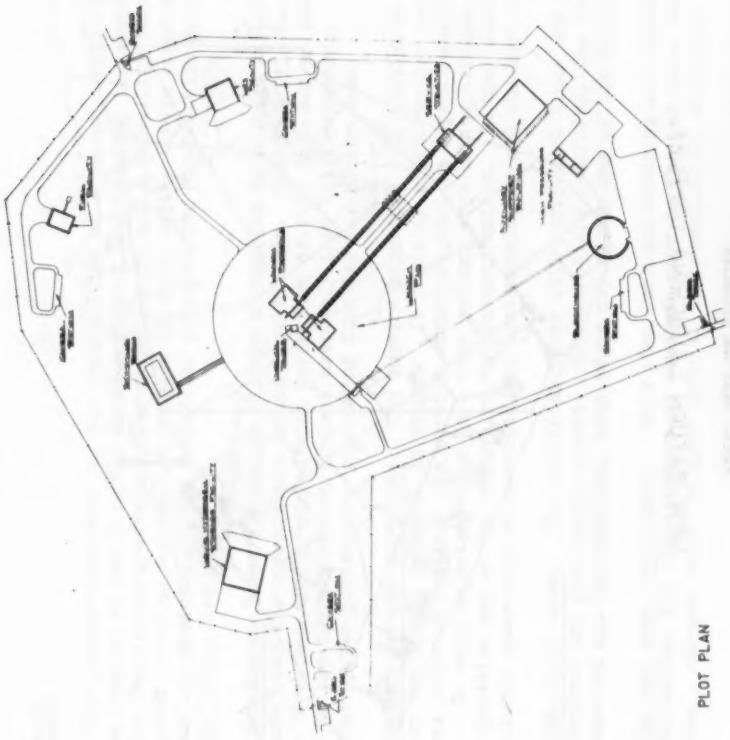
NEW SATURN LAUNCHING COMPLEX



PLOT PLAN

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

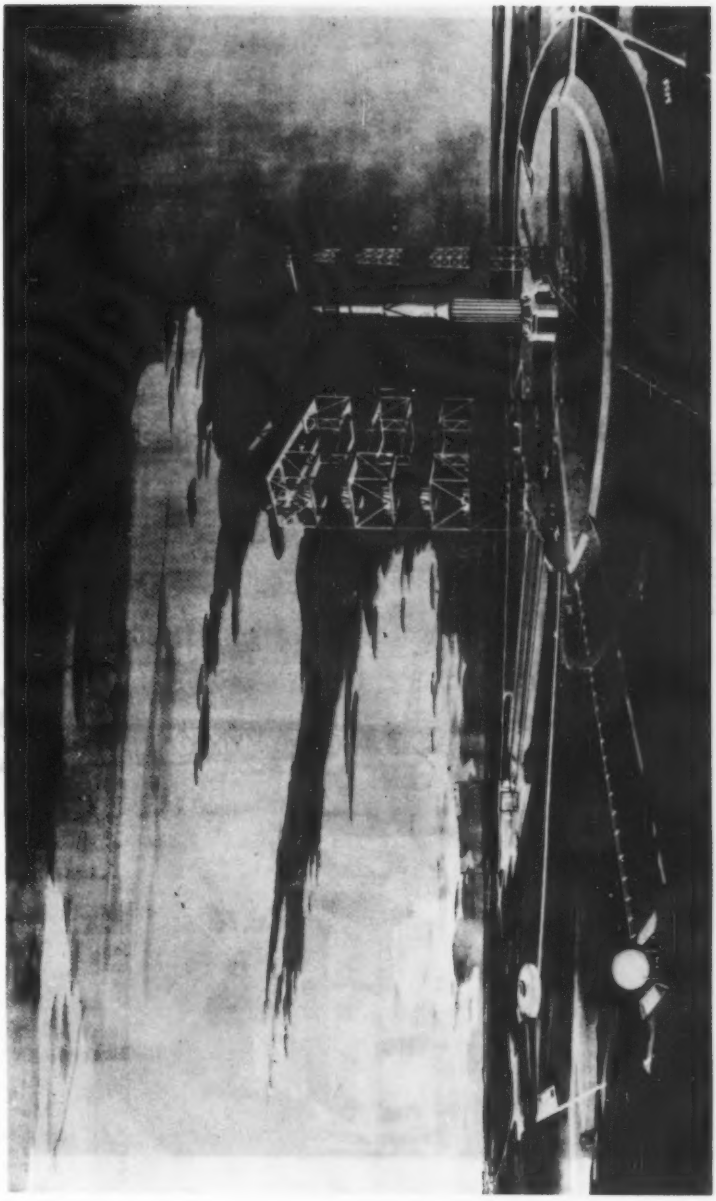
NEW SATURN LAUNCHING COMPLEX



PLOT PLAN

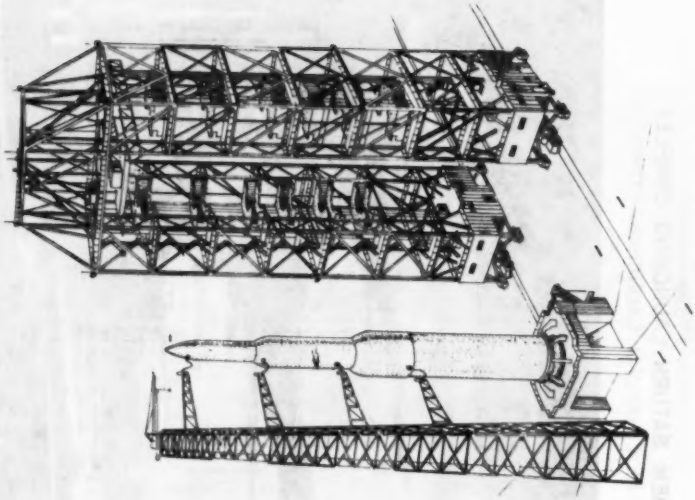
ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

NEW SATURN LAUNCHING COMPLEX



ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

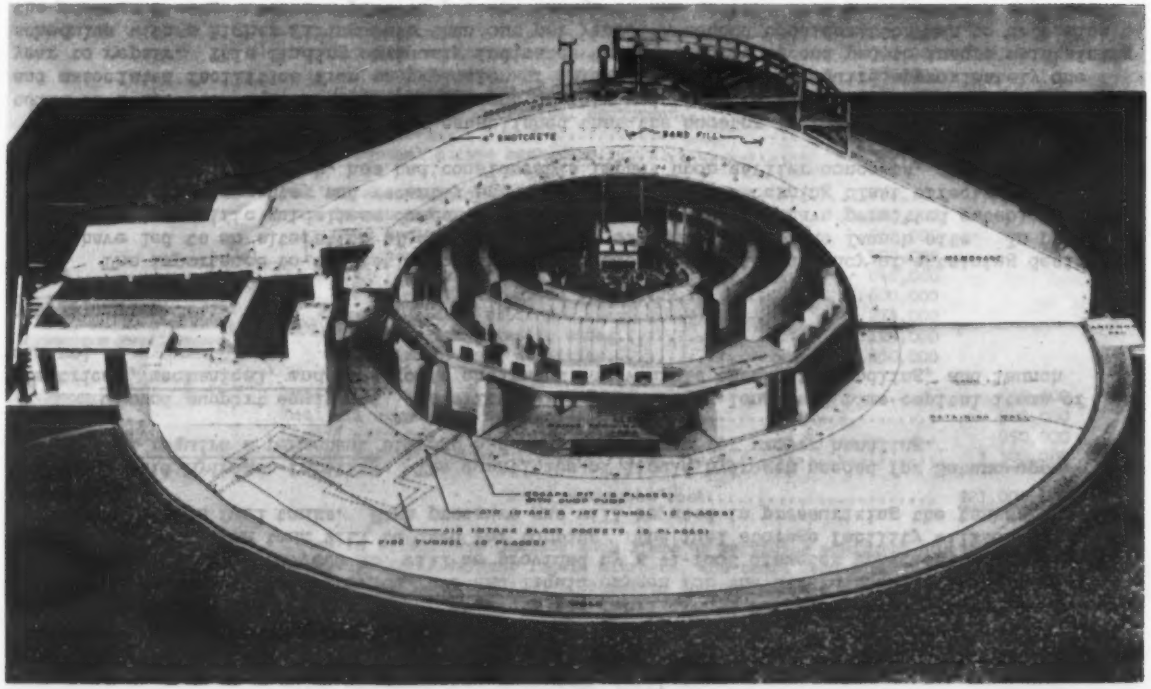
NEW SATURN LAUNCHING COMPLEX



LAUNCH STRUCTURES

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

NEW SATURN LAUNCHING COMPLEX



propellant storage facilities, and concrete roads within the complex; and extending base utilities such as water, electrical power and communications to the pad area.

Fuel, liquid oxygen, and high pressure gas facilities: Permanent storage and pumping facilities are required to provide fuel and liquid oxygen for the Saturn booster. Liquid oxygen storage capacity of 1,200,000 lb. will be provided by a 41-foot diameter spherical tank. A smaller 13,000 gallon tank will be used for topping. The fuel storage facility will contain two 28,000 gallon fuel tanks. High pressure gas will be used in pressurizing the tanks.

Liquid hydrogen facility: The quantities of liquid hydrogen needed for Saturn upper stages will require a permanent storage and transfer system for proper handling.

Ground support equipment: This item will provide for long lead time capital items of electrical, mechanical, and electronic equipment for vehicle checkout, handling, and launch control.

2. JUSTIFICATION:

The importance to the Nation of the Saturn program and the urgency of attaining desired goals have led to an alteration of certain concepts of operation at the launch site. In particular, recent specific guidelines concerning missions and schedules have permitted establishment of more firm requirements; and recently acquired information concerning blast effects of vehicles which explode during launch, has had considerable impact upon earlier concepts.

In brief, blast studies have established that the booster fuel load of 750,000 pounds could be considered equivalent to 10 percent of this weight in TNT, and that damage to the pad and associated facilities from an explosion of this magnitude would require approximately one year to repair. This finding obviously indicates the need for a second pad to insure maintaining schedules with a higher firing rate than one per year. A second consideration was to determine the minimum distance between pads to prevent damage to one missile from another which explodes on an adjacent pad. The study determined this distance to be approximately 4,000 feet. The time for checkout of complex Saturn vehicles will require that two missiles be worked on at the same time to meet firing schedules. Hence the second finding outdates the previous practice of providing common facilities for two pads; distances between pads will exceed tolerable runs for measuring leads and propellant lines. It is therefore apparent that a second, completely independent back-up launch complex is necessary to support the planned Saturn development schedule.

3. COST ESTIMATE:

pendent back-up launch complex is necessary to support the planned Saturn development schedule.

3. COST ESTIMATE:

Blockhouse		$1,675,000
Service structure		8,150,000
Railroad and anchor	$1,150,000	
Steel structure	3,100,000	
Moveable platforms	600,000	
Elevators	280,000	
Bridge crane	600,000	
Traction equipment	900,000	
Air conditioning and heating	150,000	
Communications and electrical system	670,000	
Miscellaneous mechanical equipment	230,000	
Enclosures	170,000	
Personnel escape mechanism	300,000	
Pad and area development		7,675,000
Launch pad and pedestal	1,520,000	
Site preparation and roads	965,000	
High pressure gas system	900,000	
High pressure water system	840,000	
Electrical distribution system	600,000	
Communications cabling	275,000	
Utilities and domestic water	125,000	
Extension of base utilities	2,450,000	
Umbilical tower		850,000
Fuel and oxygen storage facilities		900,000
Liquid hydrogen facility design		250,000
Ground support equipment		1,500,000
Total estimated cost		$21,000,000

Items to be deferred include such items as servicing equipment for hydrocarbon fuel, liquid hydrogen, liquid oxygen, liquid nitrogen, and short lead time instrumentation. Approximately $8,000,000 will be required to complete the equipment and activation of this facility in the fiscal year 1962.

CONSTRUCTION SCHEDULE:

Total estimated completion time	18 months

ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

STAGING BUILDING

1. DESCRIPTION AND JUSTIFICATION:

This project provides for the construction of a staging building required for the assembly, handling and mating of Saturn stages. It will provide office and laboratory spaces for upper stage contractors, storage area for spares and components, and hurricane protection for all stages, including the booster. It will contain complete checkout equipment for sub-assemblies as well as for individual stages.

The staging building will be located in an industrial area convenient to the unloading facility. Blast studies indicate that 3,000-4,000 feet from the pad is the minimum acceptable separation to remove it from the potential hazard of an explosion on the pad. A sketch of the proposed building is shown on the following page.

2. COST ESTIMATE:

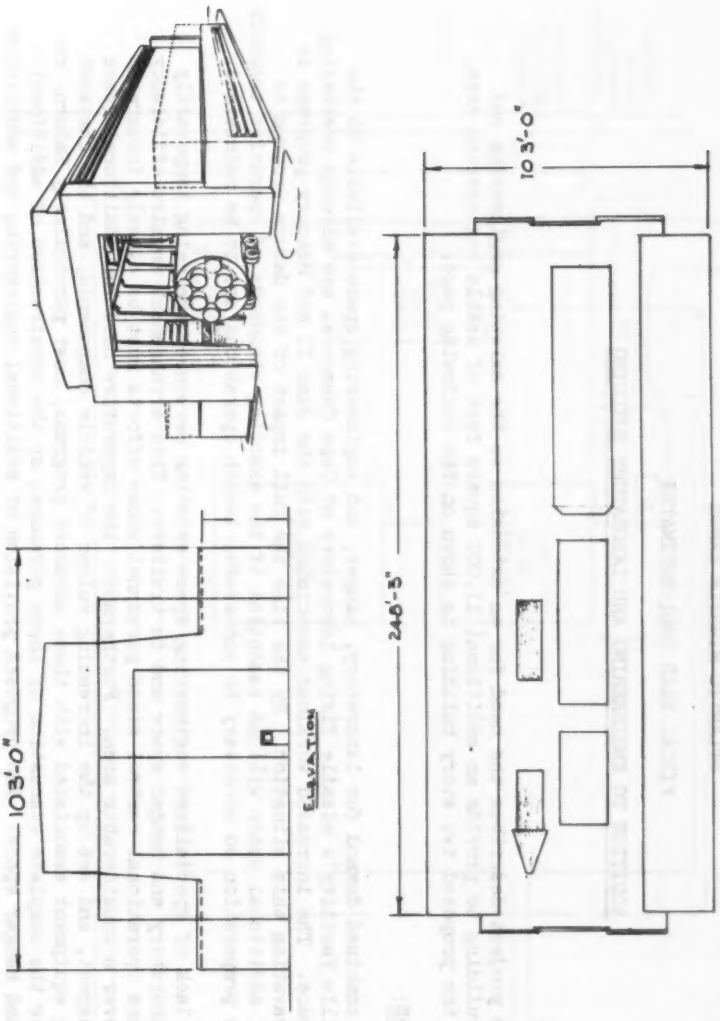
Foundations and building shell	$700,000
Partitions	150,000
Air conditioning, plumbing, and wiring	220,000
Bridge cranes	330,000
Total estimated cost	$1,400,000

3. CONSTRUCTION SCHEDULE:

Total estimated completion time	18 months

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

STAGING BUILDING



ATLANTIC MISSILE RANGE

FISCAL YEAR 1961 ESTIMATES

ADDITION TO ENGINEERING AND LABORATORY BUILDING

1. DESCRIPTION:

This project describes the need for an extension to the existing engineering and laboratory building to provide an additional 11,000 square feet of usable engineering area. A sketch of the proposed two story building is shown on the following page.

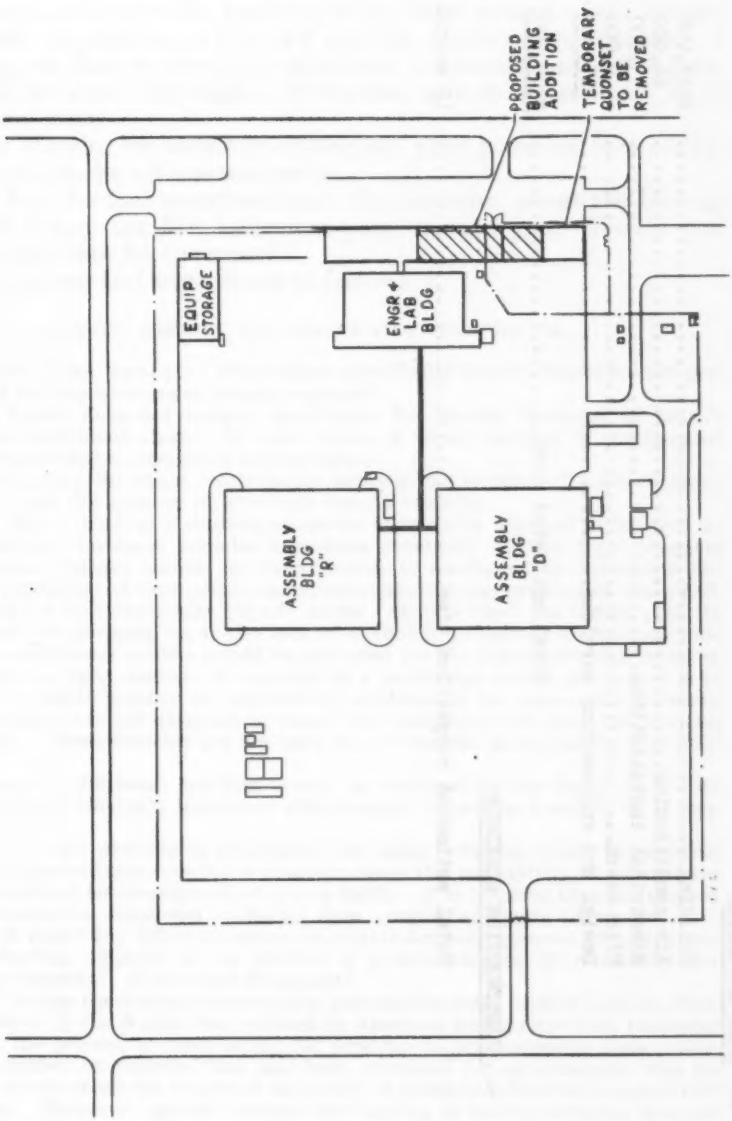
2. JUSTIFICATION:

The combined demand for laboratory, hangar, and engineering space available to the NASA Huntsville Facility's missile firing laboratory at Cape Canaveral are already overtaxing available space. The increased workload associated with the Juno II and Mercury programs is further aggravating this situation. By the time the full impact of the Saturn program is assimilated, additional space will be essential if the exacting standards of operation teamwork and hardware preparation so necessary to successful launch operations are to be maintained.

For lack of specialized engineering space existing personnel are being temporarily housed in laboratory and hangar space and in trailers. This arrangement impairs efficiency and undermines operational control since personnel whose efforts must be closely integrated are spread over a considerable area. Furthermore, the imperative need for additional space to store, inspect, and set up the increasing volume of vehicle components, and the checkout and handling equipment associated with these advanced programs, most particularly Saturn, requires either the complete evacuation of these personnel or the construction of additional laboratory and hangar space. The proposed provision of additional engineering and administrative space is decidely the cheaper solution and will enable an efficiently organized operation.

ATLANTIC MISSILE RANGE
FISCAL YEAR 1961 ESTIMATES

ADDITION TO ENGINEERING AND LABORATORY BUILDING



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3. **COST ESTIMATE:**

Building	$157,000
Air conditioning	64,000
Electrical installations	53,000
Fire alarm	9,000
Design and engineering services	17,000
Total estimated cost	$300,000

4. **CONSTRUCTION SCHEDULE:**

Total estimated completion time	12 months

Mr. HORNER. The only other thing I would like to add this evening is that Dr. von Braun will be here in the morning to discuss the major area of work at Huntsville, and that is the development of the Saturn booster and its relation to his staff and his facility requirements. I would suggest that we save any additional comments until he is here.

Senator STENNIS. All right. If we can, let's start promptly at 10 o'clock tomorrow.

Senator Martin, we certainly appreciate your presence here today. We hope you can be with us tomorrow.

I have four further questions here, Dr. Glennan, about the backup booster, if I may ask Mr. Lehrer to pass these to you. Would you please answer these for the record?

(The questions and answers are as follows:)

BACKUP BOOSTERS NOT SPECIFICALLY BUDGETED FOR

1. Does the NASA fiscal year 1961 budget specifically include funds for the procurement of backup boosters or launch vehicles?

Answer. NASA does not budget specifically for backup boosters or launch vehicles for individual shots. In some cases, a small number of unallocated vehicles are provided to support a total program.

2. Please explain the exact relationship between the number of planned space experiments and the number of available launch vehicles.

Answer. When there is a continuing series of vehicles planned to be fired at regular intervals, no spare vehicles have been provided. As the flight program develops and a failure occurs, an examination is conducted to determine the priority of repetition of that particular mission against the priority of the scheduled mission for that particular vehicle series. In this case, the lowest priority project would be dropped, or, if the lack of a vehicle presented an unresolvable problem, an additional vehicle would be procured for the lowest priority mission. When there is a fixed number of missions in a particular series, the policy is to provide for a small number of unallocated vehicles in the sense that primary payload missions are not assigned to these few vehicles at the time the vehicles are procured. These vehicles are not backups for specific shots, but for the total series.

3. How much additional funding would be required in the fiscal year 1961 budget to provide adequate insurance with respect to backup boosters or launch vehicles?

Answer. It is not possible to determine how many vehicles would be required to provide complete insurance for a program since the probability of success for any mission cannot be determined prior to a flight. It is believed that the present method of operation employed by NASA does provide adequate insurance.

4. Did you make any effort to secure executive-branch approval of additional funds for backup vehicles or to provide a greater degree of reliability for planned experiments? If so, what happened?

Answer. During the budget formulation process the total budget request originally presented by the NASA was reduced by amounts which have been indicated earlier. In the process of readjusting the program to accommodate these reductions, the number of vehicles that had been proposed for procurement was reduced, and in this sense the degree of flexibility in assigning vehicles to spacecraft was reduced. However, specific request for funding of backup vehicles was not presented in the original program and was therefore not considered in the budget formulation process.

Senator STENNIS. Is there anything else to come before the subcommittee this evening?

Dr. GLENNAN. I would just like to say, Mr. Chairman, how much we appreciate your sticking with us. We are very glad to get this before you.

Senator STENNIS. Well, it is a privilege. As Senator Martin says, you will learn a great deal here. It is very interesting, very fascinating. I am sorry that we did have some interruptions. But we did get the opportunity to learn about your major activities. Also, you may supply us with the further information for the record.

It is always nice to see you and I, personally, look forward to the times when you gentlemen are here.

If there is nothing further, we will recess until 10 o'clock tomorrow morning.

(Whereupon, at 6:05 p.m., the committee was recessed until 10 a.m., Tuesday, March 29, 1960.)

NASA AUTHORIZATION FOR FISCAL YEAR 1961

TUESDAY, MARCH 29, 1960

U.S. SENATE,
SUBCOMMITTEE ON NASA AUTHORIZATION OF THE
COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 235, Old Senate Office Building, Senator John S. Stennis (chairman of the subcommittee) presiding.

Present: Senators Stennis, Smith, Young, Cannon, Martin, and Magnuson.

Also present: Kenneth E. BeLieu, staff director, Max Lehrer, assistant staff director; Everard H. Smith, Jr., counsel; Mr. William J. Deachman, assistant counsel, Dr. Glen P. Wilson, chief clerk; Dr. Earl W. Lindveit, assistant chief clerk; and Elwyn Darden, assistant to Senator Stennis.

Senator STENNIS. The subcommittee will please come to order.

Gentlemen, we have an important hearing this morning.

The only way that this can be conducted so that our visitors may hear is for everyone to stay in place and be as quiet as possible. To that end the Chair requests your cooperation.

I am not going to make any preliminary statement this morning.

This, as everyone knows, is the hearing for the authorization for the entire program on space for the forthcoming fiscal year, involving a budget in round numbers of $900 million.

Yesterday we heard from those charged with the administration of the space program—Dr. Glennan, Dr. Dryden, and Mr. Horner. This morning we have witnesses here that are charged with the primary responsibility in certain operational phases of this program, Dr. Wernher von Braun, Dr. Abe Silverstein, Dr. William H. Pickering, and Mr. Harris J. Goett.

I am going to ask all three of you gentlemen now to stand and be sworn at the same time, if you will, please.

Do each of you solemnly swear that your testimony in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Dr. VON BRAUN. I do.

Dr. SILVERSTEIN. I do.

Senator STENNIS. Dr. von Braun, I don't think you need any introduction to any of the committee here, or any audience in Washington or in the Nation, so far as that is concerned.

We are here this morning to hear you, and to ask you to proceed in your own way. You are now Director of the George C. Marshall Space Flight Center at Huntsville, Ala. And we want to hear you

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particularly with reference to the Saturn program, or anything else that you may wish to say. And I think that you ought to emphasize to the public the importance, in this age in which we live, of this space program.

So we will appreciate any special word that you may have on that.

All right, sir, Doctor. You may proceed.

Dr. VON BRAUN. Thank you, Mr. Chairman.

I have brought a model of the Saturn vehicle along, which I would like to explain, with your permission. I also brought a number of charts along, showing what we are doing in Huntsville, what we are proposing to do with respect to some Saturn missions, and also the impact of the increased budget for 1961 on our schedule.

At the end of my presentation, I would like to show, with your permission, Mr. Chairman, a short 7-minute motion picture that was taken just yesterday, and which is a landmark in our operation of Saturn, in that it shows the first successful captive test of a Saturn booster.

Now, the Saturn is powered by eight rocket engines and our program provides that we do not turn on all the eight right from the beginning. So this test that we conducted yesterday shows an operation of the Saturn with just two of the eight engines firing. But I thought it would still be of interest to you gentlemen to see this picture.

Senator STENNIS. It certainly will be.

Doctor, if you will pardon me a minute. The Chair wishes to express appreciation for the appearance with us this morning of Senator Magnuson, who is not only a member of the Space Committee but he is chairman of the Independent Offices Subcommittee of the Appropriations Committee and has the responsibility for passing on the actual appropriations for this program.

Senator, we are very glad to have you, sir.

Senator MAGNUSON. Thank you.

TESTIMONY OF DR. WERNHER VON BRAUN, DIRECTOR, GEORGE C. MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

Dr. VON BRAUN. Thank you, Mr. Chairman.

May I step over to this corner now and explain this?

Senator STENNIS. Certainly.

Dr. VON BRAUN. The Saturn vehicle is a three stage or four stage rocket of great payload capability. It will be used with three stages for relatively low speed missions—relatively speaking, that is. For carrying large payloads, it will be used in orbit around the earth. It will use a fourth stage only on such missions where greater speeds are necessary, such as flight to the moon or for interplanetary probes.

INTERIM VERSION OF THE SATURN IS CALLED THE C–1

There will be an interim version of the Saturn and a final one, and the interim version is what you see here. We call it the Saturn C–1.

It consists essentially of the booster, which is powered by eight rocket engines of 188,000 pounds thrust each, for a total of 1½ million pounds of thrust. The propellants are kerosene and liquid oxygen, and they are carried in a cluster of nine tanks. Eight of these tanks are on the periphery. Four carry fuel and four carry liquid oxygen and there is one central tank, which is also filled with liquid oxygen.

Each of the eight rocket engines has its own turbopump feed system, and can be shut down as a separate unit. The entire rocket has a capability of flying on seven out of the eight engines, so you have an engine out capability comparable to that of a multiengine aircraft. This booster pushes the whole rocket up to approximately mach 5, which is five times the speed of sound. At this point, the booster is jettisoned, and the second stage takes over.

The second stage has its own four engines, which are powered with liquid hydrogen and liquid oxygen. Each of these engines has 20,000-pound thrust. They are manufactured by Pratt & Whitney in West Palm Beach, Fla. The first stage is powered with engines manufactured by the Rocketdyne Division of North American Aviation, in Los Angeles.

After the second stage is burned out, the third stage takes over. This third stage is likewise loaded with liquid hydrogen and liquid oxygen, and carries two engines identical to the four in the second stage.

Everything on top of this, then, is payload.

The C–1 Saturn configuration that you see here can carry a payload of approximately 25,000 pounds in orbit around the Earth, and approximately 12,000 to the Moon, in a hard landing.

Now as I mentioned before, this is only an interim version. The Saturn vehicle has basically much greater capabilities. But to develop these greater capabilities we first have to develop a new rocket engine. It will use liquid hydrogen and liquid oxygen, and will generate 200,000 pounds of thrust, which is 10 times as much as the individual engine on the present second stage.

Once this more powerful engine is available, we can create a new second stage, with much more propellent load, and place this new more powerful second stage between the present second stage and the booster. So that what used to be the second stage will now become the third stage.

SECOND GENERATION SATURN IS CALLED THE C–2

This Saturn, the second generation Saturn, we call the C–2 configuration.

Now we can fly this vehicle for low orbits, in which case all of this space will be used for payload, and the payload capacity will be in the order of 50,000 pounds, or approximately twice as high as that of the interim configuration. But for high speed missions, like going to the Moon, or for planetary probes, we can replace part of this payload by a fourth stage, and for this we would use the same vehicle that was used as a third stage in the interim vehicle, and in this case, of course, our payload is smaller again.

This C–2 configuration can easily carry two men around the Moon, and bring them safely back into the atmosphere of the Earth. I would like now to proceed with my charts and report to you what we are doing in Huntsville.

This booster is under development at the George C. Marshall Space Flight Center, in Huntsville, Ala.

The first stage of the Saturn vehicle is under development as an in-house project in Huntsville. It is our intention to have the development of all upper stages carried out by contractors in industry. In fact, the top stage that you see here is already under development at Convair Astronautics in connection with the Atlas Centaur program. We plan to use this stage as a third stage of the Saturn C–1, and as a fourth stage of Saturn C–2.

These charts deal with the development of the first stage only, in other words, the work that goes on in Huntsville.

MOVING THE SATURN FROM HUNTSVILLE TO CAPE CANAVERAL

Here you see how the complete booster will be transported from the assembly hangar to our docking facility on the Tennessee River (chart 36, Saturn Transporter and Tug), where the booster will be rolled on to a barge (chart 37, Roll On-Roll Off Barge Concept), which will take it to Cape Canaveral for launch. This barge is already under contract, and we expect delivery later in the year.

It is our plan to tow this barge down the Tennessee and Ohio Rivers, down the Mississippi, and then across the Gulf of Mexico, and around the tip of Florida to Cape Canaveral. Tugs will take it as far as New Orleans, and a seagong ship will take it across the gulf. The barge will be taken off the seagoing LSD again before it goes into the intercoastal waterway, and finally a special docking facility at Cape Canaveral, adjacent to our launch facility, will be used to unload it and bring it to the launch pad (chart 38, Saturn Booster Transportation).

This is a schematic view of the launch facility that we are presently building in Cape Canaveral for the Saturn. Here you see the three-stage vehicle sitting on the launch pad, with a service structure and the propellent-loading facilities for liquid hydrogen and liquid oxygen in the upper stages.

This is the blockhouse from which the firing will be carried out (chart 39, Propellant Loading System—Saturn).

There are, of course, a few other facilities in this area that are not shown. We plan to use this facility for our first launching sometime in the summer of 1961.

CHART 36

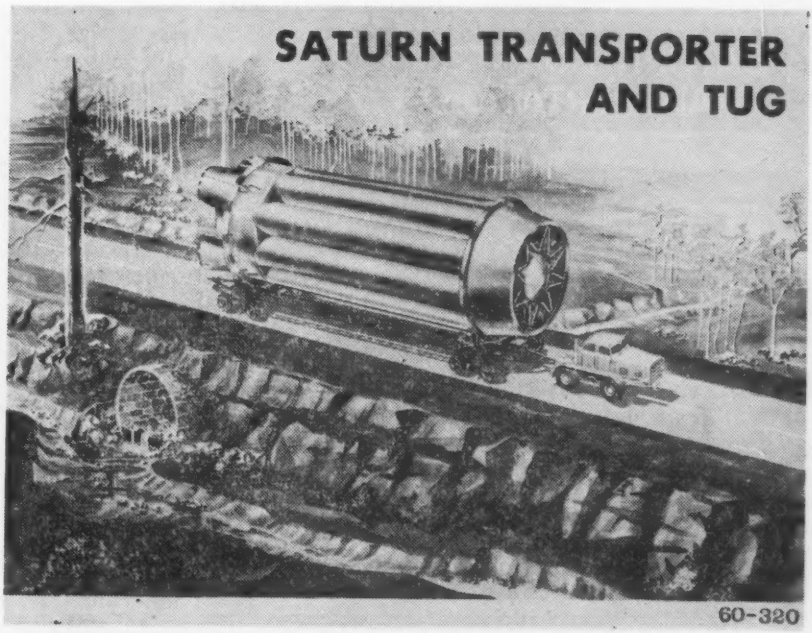


CHART 37

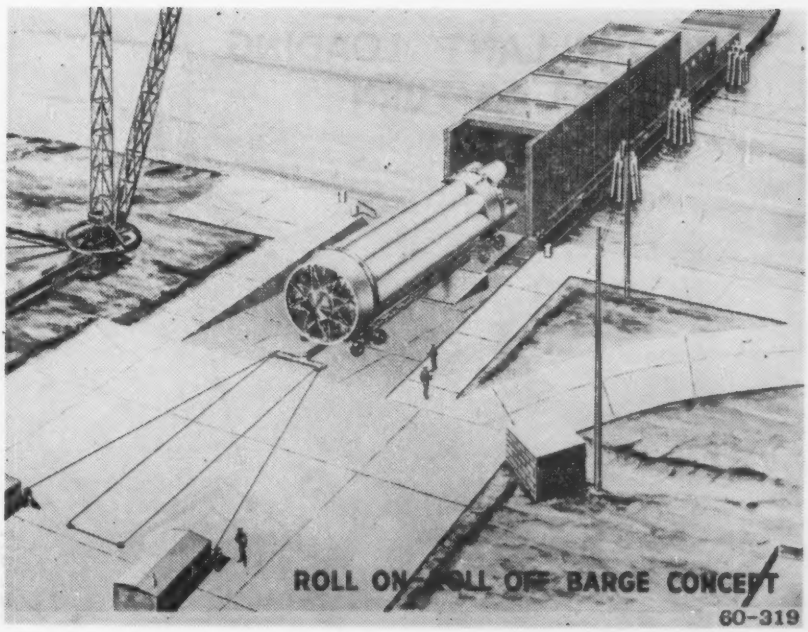


CHART 38

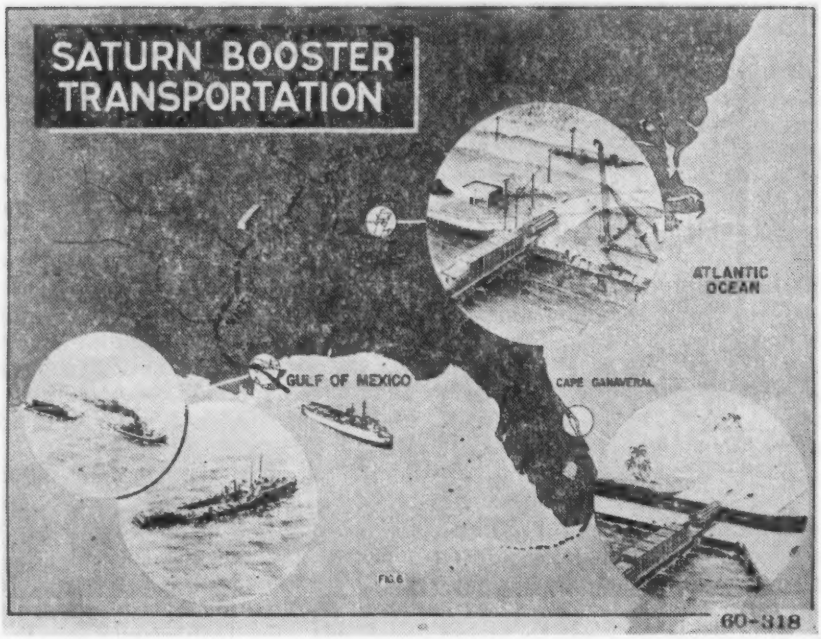
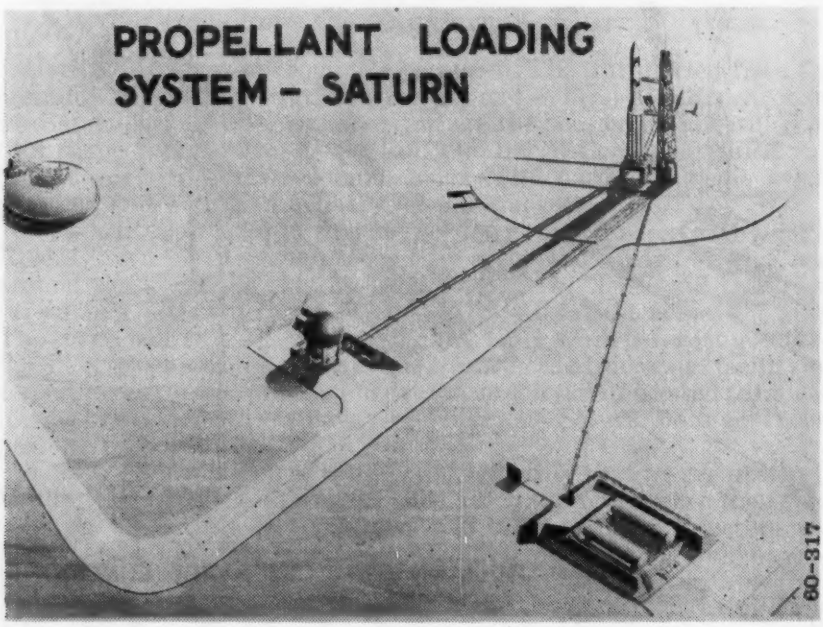


CHART 39



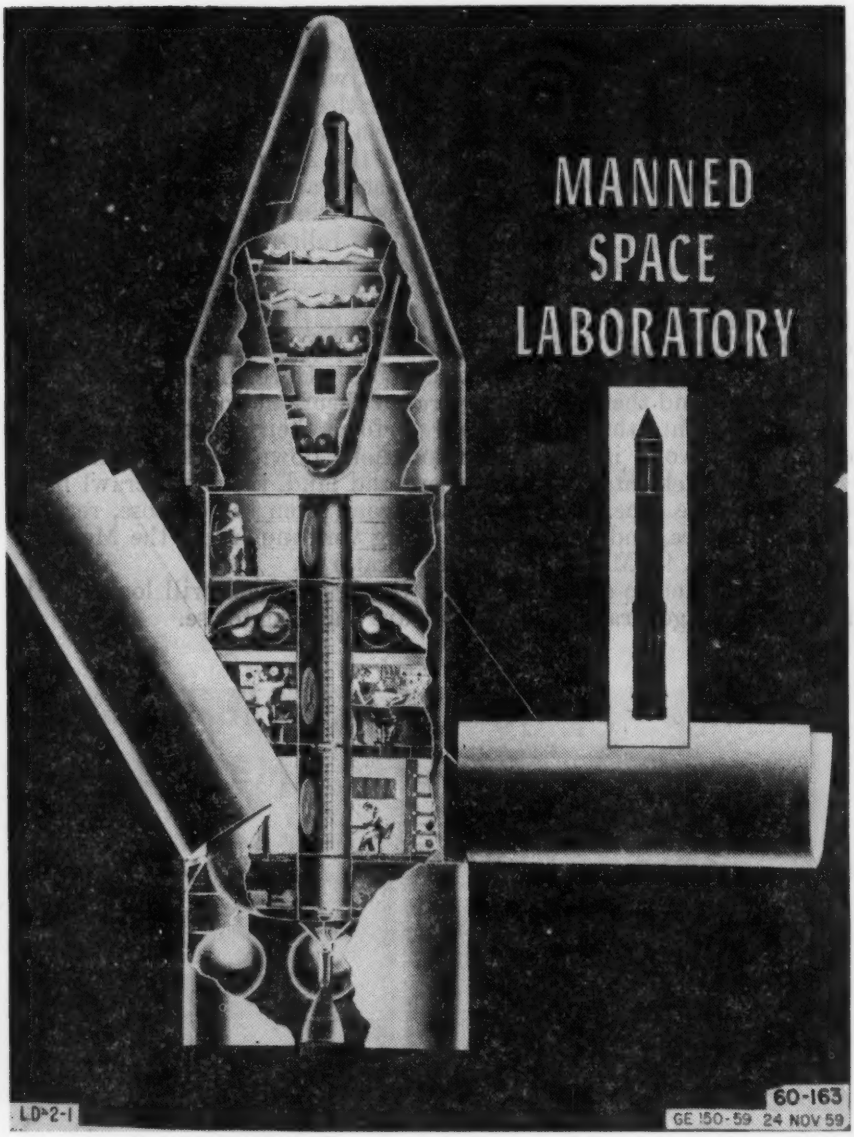
POSSIBLE MISSIONS FOR SATURN

This illustration deals with some of the possible missions, for which Saturn could be used. We are talking here about payload capabilities of 25,000 pounds, or a little over 12 tons, with the C–1 configuration, and about 25 tons, or 50,000 pounds, for the C–2. This, of course, is much more than what is needed to carry a single man, or a piece of instrumentation into orbit. We believe the main purpose of Saturn will ultimately be to provide manned space transportation.

Before we know how to use men efficiently in outer space, many tests will be necessary, and for these tests, the following scheme is one of those envisioned. There will be a nose cone carried aloft to the orbit, which will be built very much on the basis of NASA's present work in Project Mercury. There will be attached to this nose cone a separate compartment which is not capable of reentry into the atmosphere, which we usually refer to as the caboose. Once in outer space, the astronauts—and there will be several of them—riding up in this nose cone, can go into this caboose and perform their space research and exploratory work in the accommodations down here. When they want to go back into the atmosphere and land, they will crawl back into their nose cone, detach the nose cone from the caboose, reenter the atmosphere, and perform a landing very much like the Mercury vehicle (chart 40, Manned Space Laboratory).

This may not be exactly the way the first vehicle will look, but it illustrates the general scheme that we are planning to use.

CHART 40



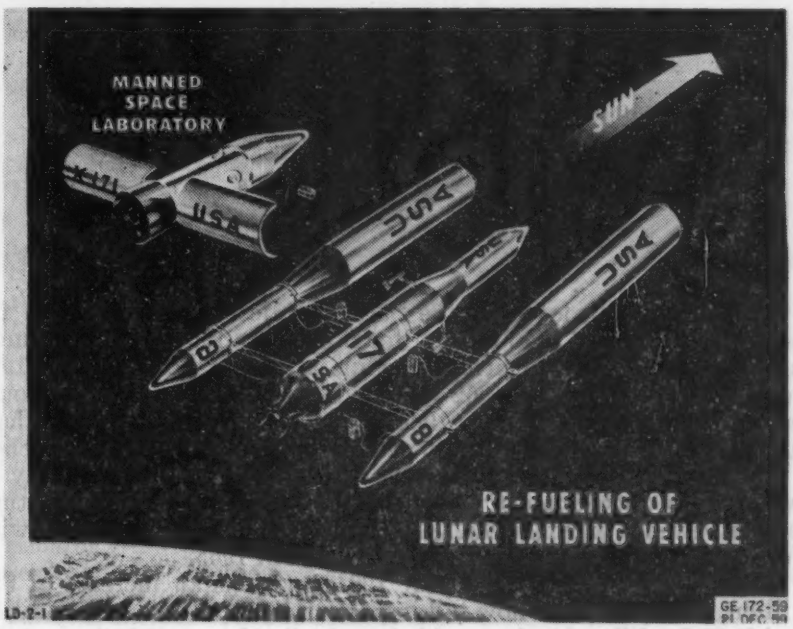
REFUELING THE SATURN IN ORBIT

Another important consideration for a vehicle the size of Saturn is that you can extend its performance for deep space missions if you use what we call a refueling operation in the orbit. That is, a Saturn filled with propellants in its payload compartment will be used as a tanker, and several of these tankers will carry hydrogen and liquid oxygen fuel up into orbit for the purpose of refueling one vehicle that has been flown up there in a previous Saturn flight.

By refueling this vehicle, with the payload carried up to the orbit by these tankers, its range can be very greatly extended. In this manner it appears possible to land a crew of several people on the surface of the Moon and fly them back to Earth, or even launch manned expeditions into interplanetary space.

There are actually two ways of doing this. One is to physically transfer the propellants from tank to tank. Another possibility is to just latch the tanks together, and use the tanks—the payload tanks of the tanker—as propellant supply for the deep space ship (chart 41, Refueling of Lunar Landing Vehicle).

CHART 41

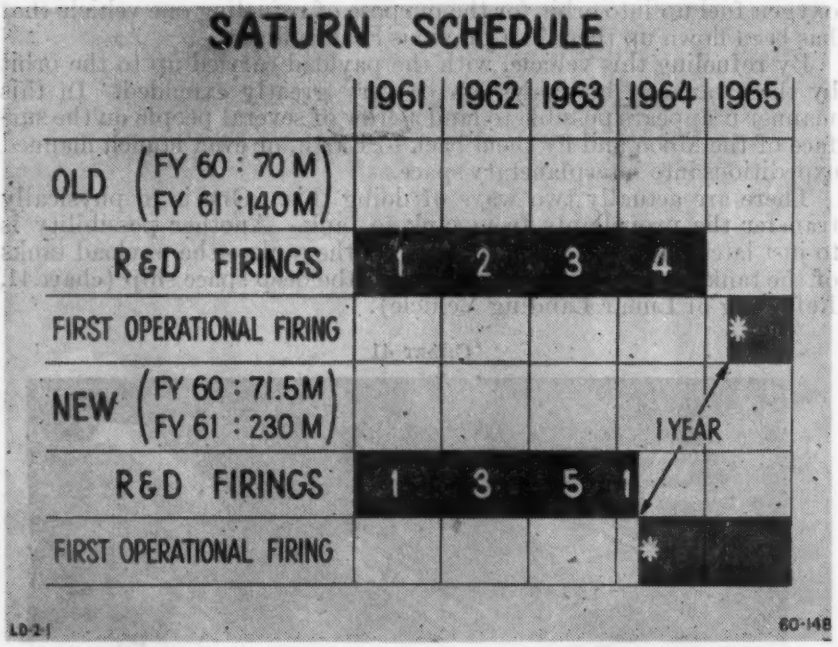


Such techniques must be developed after the first phase of the Mercury program has been successfully completed, because it will involve human operations in outer space, and we have to know how well personnel can perform under zero gravity conditions in an orbit.

TEN RESEARCH AND DEVELOPMENT FIRINGS NECESSARY BEFORE FIRST OPERATIONAL SATURN FLIGHT

My last chart deals with the impact of our increased funding level on the Saturn schedule (chart 42, Saturn Schedule).

CHART 42



Our old funding level for the Saturn project was $70 million for fiscal year 1960, and $140 million for fiscal year 1961. On this funding level, the following firing schedule appeared possible. In 1961 we could have fired 1, in 1962 we could have fired 2, in1963 we could have fired 3 Saturns, and in 1964 a total of 4, and if we add these figures up it makes a total of 10 research and development launches.

Since we have said from the outset that we need approximately 10 research and development firings before we can declare the Saturn as an operational vehicle, the first operational firing of a Saturn with No. 11 could have taken place in the first part of 1965.

The new budget for fiscal year 1961 envisions an increase of $90 million, so that we are now talking about $230 million. In addition to this $1.5 million has been added to the fiscal year 1960 budget, by refinancing within the present NASA budget.

This $1.5 million is presently being used to finance overtime, both in Huntsville and with contractors, to speed up the work. This money of course will be spent by the first of July of 1960, when fiscal year 1961 begins.

CURRENT SCHEDULE WILL GAIN APPROXIMATELY 1 YEAR

The extra $91.5 million will give us the following speedup in the Saturn program. Of course, in 1961 we can still fire only one. This we cannot accelerate. But in 1962 we will now be able to fire three instead of two, in 1963 we plan to fire five instead of three, and in early 1964 one more, so that still in the first half of 1964 we will be able to fire No. 11, the first operational Saturn.

This means a gain of approximately 1 year with respect to the old schedule. And this is what we honestly think we can do with this increased funding level (see pp. 252–253).

May I now show our picture of the firing yesterday?

Senator STENNIS. All right, Doctor.

Right at this point, Doctor, you will put in the record the copies of your charts.

Dr. VON BRAUN. Yes, sir.

(The charts referred to appear in their respective places in the text.)

SUBCOMMITTEE SEES MOVIE OF FIRST SATURN TEST FIRING

(At this point the moving picture film was exhibited.)

Dr. VON BRAUN. You see the vehicle being fueled here. What comes out of the pipe is the vapor from the liquid oxygen. Liquid oxygen is pumped into the tanks, and it is just evaporation that you see there.

Here you see through the window of the blockhouse, looking toward the static test stand. What you see on the right side is the Jupiter IRBM.

To the left you see the Saturn booster. They have just turned on the cooling water for the jet deflector. You can see the two engines sticking out of the tail end of the clustered tanks.

Here the engines fire up.

We fired it for only 8 seconds on the first try. Total duration of a Saturn booster is approximately 120 seconds. The tankage you see suffices for full duration operation of the eight engines.

Here you see what the test stand looked like prior to modification. The right side of the test stand was what we used for the Jupiter IRBM testing, and everything you see on the left side was the modification we made for the Saturn program.

Mr. Chairman, this ends my presentation. I will be now glad to answer any questions you may have.

Senator STENNIS. Doctor, as I understand, we have just witnessed here the showing of the first actual static firing of the Saturn project. Is that correct?

Dr. VON BRAUN. That is correct, sir. I would like to remind you that these were only two of the engines. We plan to fire up four within the next week, and then proceed from there to eight, if everything works well, within another week or two.

Senator STENNIS. So this is the first firing, then, of what will be the million-and-a-half-pound cluster, and to that extent, it is a milestone—an historic occasion.

Dr. VON BRAUN. For the Saturn program, yes, sir.

LAST YEAR'S RECOMMENDED SATURN FUNDING COMPARED WITH CURRENT REQUEST

Senator STENNIS. Now, I have a few prepared questions here the answers to which I would like to have clearly in the record. I think you have already partly covered quite a few of these.

Last year you urged approval of an accelerated Saturn program which would have involved funding of approximately $127 million in fiscal year 1960, and $250 million in fiscal 1961. Your chart here shows that only $71½ million has been made available for you in fiscal 1960 instead of $127 million that you urged.

Now, the year is not yet up. Do you need additional funds in the fiscal year 1960?

Dr. VON BRAUN. Sir, I asked for these $127 million approximately three-quarters of a year ago, when the bulk of fiscal year 1960 was still ahead of us.

Now, we still have only the months of April, May, and June to go. I do not believe that anything close to another $50 million could be spent. I think with the $1.5 million additional funds in 1960, plus a minor other adjustment that NASA plans to make, we will be all right.

Senator STENNIS. The $1½ million takes care of your overtime and other minor additional matters that you have encountered, is that right?

Dr. VON BRAUN. That is correct, sir.

(NOTE: See p. 376.)

Senator STENNIS. You state that you have now requested $230 million for the Saturn for the fiscal year 1961, and that will advance your operational booster completion date by approximately 1 year. How does the current Saturn schedule compare with your recommended program schedule which was turned down last year?

Dr. VON BRAUN. Well, sir, it may look as though there is $20 million missing—the difference between $250 million and $230 million—but actually this is not quite the case for the following reason.

In addition to the $230 million that I mentioned here on this chart, there is an amount of $15 million additional in the NASA budget for the development of the new 200,000-pound-thrust hydrogen liquid oxygen engine which we will use in the second version of the Saturn.

There is also an amount of an additional $8 million for the Centaur program, which of course will make flights with the Atlas ICBM as a first stage booster, before we use it on the Saturn. If you add these $23 million to this budget, then we have $253 million.

DR. VON BRAUN SAYS $230 MILLION BUDGET REQUEST WILL MEET HIS REQUIREMENTS

Senator STENNIS. Well, I think the key question now is, will this $230 million that is requested for your 1961 budget meet your requirements?

Dr. VON BRAUN. Yes, sir.

Senator STENNIS. That is the main question.

Dr. VON BRAUN. Yes, sir, it does.

Senator STENNIS. You think it will?

Dr. VON BRAUN. I do, yes, sir.

Senator STENNIS. All right.

THE UNITED STATES HAS PRODUCED MORE SCIENTIFIC KNOWLEDGE BUT THE RUSSIANS STILL HAVE GREATER PAYLOAD CAPABILITY

Now, going into another phase of it, a year ago you testified that in your judgment it would take 5 years at least for us to equal the Russians in their space capabilities. What would be your estimate now? What is your present appraisal with reference to that situation?

Dr. VON BRAUN. Well, sir, I think we had an impressive number of successful satellite and deep space flights during the past year. I think in the area of scientific achievement, in the field of space exploration, we probably have caught up very well. In fact, many people believe that we have produced more scientific knowledge with our smaller vehicles than the Russians have with their much larger ones.

Senator STENNIS. Do you share that opinion?

Dr. VON BRAUN. In the scientific field, yes, sir. But I believe the Russians still have an edge on us in payload capability, and it is for this reason that it is felt that the Saturn booster is so vitally necessary.

The Saturn booster will be at least twice as powerful as the most powerful Russian rocket demonstrated so far, and if we continue working on the Saturn, at an accelerated rate, we feel we have a very good chance of catching up with the present Russian payload capabilities.

Senator STENNIS. When you say payload capabilities, you mean because of the increased thrust that will be available?

Dr. VON BRAUN. It simply means we can carry larger payloads into orbit, or to the Moon, and we do not have to economize with our weight to the extent that we have had to do it in the past. This in itself will permit us to accelerate the payload program also.

VON BRAUN FEELS CURRENT ACCELERATED SCHEDULE "IS ABOUT AS FAST AS YOU CAN RUN"

Senator STENNIS. Well, what you say is encouraging. And you have never been inclined, so far as we have observed here, to try to overstate or sugar-coat anything.

Considering this progress now that has been made, would you put a yardstick on this matter, like you did a year ago, when you spoke of 5 years? I know that no one should be held to accountability for estimates of this kind. But what do you think about it on a time basis now?

Dr. VON BRAUN. The difficulty with which I am confronted in answering this question clearly is that I do not know what the Russians are doing at this time, and it is quite likely that they also have a more powerful booster project under development.

All I can say is that I do not believe that we could intelligently move much faster than this accelerated schedule that we have here. This is about as fast as you can run. But not knowing how fast the Russians are running, I do not know whether our weight-carrying capability will really exceed theirs a number of years from now.

Senator STENNIS. So far as your projects are concerned, and considering the appropriation of money, which is certainly the responsibility of the Congress, you think that you are fixed up now and have

the funds to take care of your foreseeable needs, plus the contingencies that might arise; is that correct?

Dr. VON BRAUN. Yes, sir; I would say in fiscal year 1961 this is the case; yes, sir.

EXPANDED SATURN PROGRAM CREATES NEED FOR NEW FACILITIES

Senator STENNIS. Now, here is a question that goes back into this transfer of the Army Ballistic Missile Agency. Would you have required all the facilities being requested in NASA's 1961 budget if your activity had remained with the Army?

Dr. VON BRAUN. Sir, the majority of the facilities requested and under consideration now for fiscal year 1961 are not needed because of our separation from the Army, but because of the expedited Saturn program.

In order to implement this accelerated program, we need two static test stands. We have to get a second launching facility in Canaveral underway. We have to extend certain shops and laboratories. This is not caused by the separation.

Senator STENNIS. Yes. That is a part of the progression of your program.

Now, getting down to one special item here: You have a proposed central laboratory office facility which is estimated at $4.4 million. How does the necessity for that arise? What is your justification for that?

Dr. VON BRAUN. Sir, part of this need is caused, of course, by the separation. The Army has analyzed its own continuing need for laboratory and office space, and has determined that what used to be the old headquarters building of ABMA, which of course also accommodated some of our technical activities, will be needed in toto for the Army. For that reason, NASA would have to build its own central laboratory and office facility.

Senator STENNIS. You have an agreement now with the Army, as I understand, as to what facilities will be kept by them, and what will be turned over to you?

Dr. VON BRAUN. Yes, sir. This agreement provides specifically that this building will remain with the Army, and NASA will build a new one. If we do not get this building, then we have a real difficulty with the Army.

TRANSFER COOPERATION WAS SMOOTH

Senator STENNIS. This is a general question, but have you had the cooperation of the Army in making this transfer, without lost time or injury to the progress of the program?

Dr. VON BRAUN. The cooperation went on very smoothly. We had very few difficulties whatsoever—except in areas where a genuine conflict exists, such as in the case of this laboratory building.

I feel it is really vitally needed that this building be approved for fiscal year 1961, because if we do not get the building, then there will be delays in the program.

Senator STENNIS. The Chair is not going to ask any more questions now. We will yield to Senator Magnuson, who is a member of the Space Committee, and the Appropriations Subcommittee chairman, who has to go to the Senate floor.

$230 MILLION FOR ACCELERATED SATURN SCHEDULE IS INCLUDED IN OVERALL BUDGET REQUEST OF $915 MILLION

Senator MAGNUSON. I am sorry we have to go to the floor. We have an appropriation bill up, and there is a quorum call. I did, however, want to ask this, Doctor:

When you say "old" concerning the schedule on the Saturn, and when you asked for $140 million in fiscal 1961—is that what you asked the Bureau of the Budget for?

Dr. VON BRAUN. No, sir. The $140 million was the old budget figure prior to the recommendation by the President to allot more funds to the Saturn. The new figure is $230 million.

Senator MAGNUSON. Now, has the Bureau of the Budget approved the $230 million?

Dr. VON BRAUN. The President has recommended it to the Congress.

Senator MAGNUSON. We probably could assume the Bureau of the Budget would then approve of it?

Dr. VON BRAUN. Yes, sir.

Senator MAGNUSON. Now, that is the matter before this committee, as I understand it, Mr. Chairman, for the authorization of that amount?

Senator STENNIS. That is correct, the authorization.

Senator MAGNUSON. For the 1961 budget.

Now, they are now holding hearings in the House for the regular budget for the Space Agency. As I understand it, the House will finish the bill sometime within 2 weeks, depending on other conditions that would shorten it. Then the Senate will immediately begin hearings on the appropriation for the Space Agency, probably the second week in April.

In the meantime, considering the time element involved, would there be any conflict between the recommendation here, so that we in the Appropriations Committee might at least consider the proposal for the $230 million between now and—well, the next 30 days?

Senator STENNIS. I think we will handle this bill rather rapidly, Senator. These hearings are moving along fast. I think it will all be clarified before the bill gets to you.

Senator MAGNUSON. You see, otherwise, Doctor, it will be very difficult for the Appropriations Committee to consider an item that hasn't been authorized.

FISCAL YEAR 1961 APPROPRIATION BILL PROVIDES FOR EARLY AVAILABILITY OF SOME NASA FUNDS

Mr. HORNER. Senator, there is a provision in the fiscal year 1961 appropriation bill that is under consideration in the House at the moment for early availability of funds to meet the immediate needs for the Saturn program. If that bill is passed in the House, the bill that will come to the Senate will provide for our early availability of funds for that purpose.

Senator MAGNUSON. And then, in the regular budget—how much would you ask for?

Mr. HORNER. Well, this anticipates, of course, the approval of the entire $915 million which includes the $230 million for Saturn and, on the basis of the provision for early availability of $21 million of

this amount, this will cover the requirements for the program between now and the end of this fiscal year, as well as the requirements for the next fiscal year.

Senator MAGNUSON. So that if the Appropriations Subcommittee on Space would approve the total amount asked for by the Space Agency, we are to assume that that would then include the $230 million, or the availability of $230 million?

Mr. HORNER. It does indeed; yes, sir.

Senator MAGNUSON. So that this program, if we decided we should speed it up, as suggested by Dr. von Braun, would go ahead in fiscal 1961?

Mr. HORNER. That is correct.

Senator MAGNUSON. Thank you.

Senator CANNON. Will the Senator yield? On that point, I am wondering, was the $140 million the figure included in the President's Budget submitted to Congress this year?

Mr. HORNER. That is correct.

Senator CANNON. And the additional $90 million has been submitted since that time, and was not within the budget as initially presented to the Congress when there was supposed to be a certain amount left over.

Mr. HORNER. The budget as originally submitted was for $802 million total for the National Aeronautics and Space Administration. There has been added to it $113 million, of which $90 million was specifically for this project.

Senator MAGNUSON. So that Dr. Glennan will ask for the $915 million?

Mr. HORNER. That is correct.

Senator MAGNUSON. And if we should approve of that, then Dr. von Braun's suggestions that we could speed this up a year would be possible within the availability of the funds?

Mr. HORNER. That is correct. The new Saturn program as outlined by Dr. von Braun will be in the 1961 budget.

Senator MAGNUSON. Thank you, Mr. Chairman.

Senator STENNIS. Yes, sir. Thank you, and we appreciate your coming in, Senator.

Senator Smith, we will follow the general rule, without strictly enforcing it—but the general rule of 10 minutes.

PRESS REPORTS NOT ACCURATE ON ABMA RESIGNATIONS

Senator SMITH. Thank you, Mr. Chairman.

I, also, must go to the floor for the appropriations bill.

One of the principal reasons advanced for transferring the development operations division of ABMA from the Army to NASA was that this would make it possible to keep the Von Braun team intact. Recently, there have been a number of newspaper stories stating that 15 of your scientists, headed by Frederick K. Mueller, Deputy Director of the ABMA Guidance and Control Laboratory, are resigning to work for a newly established private industrial firm in Huntsville, Ala. Dr. von Braun, are those press reports correct?

Dr. VON BRAUN. No, Senator, they are not correct. So far we have been notified by only three men that they plan to resign. The figure

of 15 is not supported by the facts. The reason for this resignation is the following, and I think it is really not serious at all.

Our new assignment at the Marshall Space Flight Center, as given to us by NASA, provides that the Huntsville facility will be mainly in charge of the development and the management control of industrial development for space vehicle systems—that is, for the large rocket vehicles that are necessary to carry payloads into orbit.

We will be less concerned in the future with payload design and scientific space missions. This, of course, requires a certain reorientation of our own development. The particular group that is involved in discussions with an industrial firm specialized in the development of small gyroscopic platforms that are very vital elements in the development of intermediate range ballistic missiles. But in our new assignment, there is really no great need for a further continuation of this kind of development.

We have invited these men to forget what they have done for the last 25 years and take an interest in other fields; but they feel that their special capability in the gyro work gives them such a good position in that field that they would rather remain in their chosen line of work. And since we cannot provide them with sufficiently interesting work in that area, we do not object to their joining a company that plans to remain in the field.

Senator SMITH. Are you saying, then, that it will not hamper the program?

Dr. VON BRAUN. It will definitely not hamper the program. These people are very competent. We appreciate what they did for us in the past. But under our new assignment, we have only two alternatives—either giving these people a new assignment foreign to their own experience, or having them leave the organization.

THERE WILL BE CERTAIN PERSONNEL LOSSES TO THE ARMY

Senator SMITH. Have there been any other significant personnel leaving; or do you anticipate any?

Dr. VON BRAUN. No, ma'am. There is one area where we have to expect certain losses in the near future. We have promised the Army to create a continued capability in the missile field for the Army, so that the Army can, shall we say, spawn a missile capability of its own. This will require that some of our top people remain with the Army. But here again, we think we are strong enough to spawn a new organization and still meet our obligations to NASA.

Senator SMITH. You feel that that will not hamper you, or delay the progress?

Dr. VON BRAUN. No, Senator, I think it will not. On the contrary, sometimes it is good in an organization if you assign new jobs to some of the top people, because it gets younger people to the top.

PERSONNEL TURNOVER RATES AT HUNTSVILLE ARE SMALL

Senator SMITH. How does the turnover of scientific and technical personnel at Huntsville compare with that of other NASA activities? Is there a turnover? How does the turnover of your personnel at Huntsville compare with other NASA activities?

Dr. VON BRAUN. Senator, I am not quite familiar with the turnover rates in other NASA facilities, but I can answer the question in terms of industrial averages. There our own turnover figures are much lower than in the missile industry.

MOST PERSHING PROJECT PERSONNEL TO REMAIN WITH ARMY

Senator SMITH. Dr. von Braun, in reply to a question asked by this committee on February 16, 1960, relative to the transfer of employees of the Development Operations Division of the Army Ballistic Agency to NASA, Mr. Albert F. Siepert, NASA's Director of Business Administration stated:

Both NASA and the Army will report the right of the individual employee to make his own choice if he is sought by other organizations.

To what extent have you observed that employees are choosing the Army instead of NASA as their future employer?

Dr. VON BRAUN. The most immediate Army project that must be continued in Huntsville that requires our continued support is, of course, the Pershing missile system. We have asked those employees in the former Development Operations Division in Huntsville, that were intimately connected with the Pershing program, to remain with the Army.

Now, some have objected and want to stay with the team and transfer to NASA. In this case we have accepted their wishes and have transferred them. But the majority of the personnel involved saw that they had an obligation first to finish up the Pershing system, and so they elected to remain with the Army.

MAKING TWO ORGANIZATIONS OUT OF ONE CREATES SOME DIFFICULTIES

Senator SMITH. In the committee's hearings on the transfer of the Huntsville facility to NASA, another statement was made, and I quote:

Some individual difficulties will develop as NASA seeks to find exceptionally qualified employees at Redstone who can fill key spots in the NASA management organization.

Have these difficulties been encountered?

Dr. VON BRAUN. I think there are some transitional difficulties simply caused by the fact that we are trying to make two organizations out of one. May I add my personal feeling that while this leads to transitional difficulties, it also has great advantages in that it breaks the crust of an old entrenched organization, and brings new blood to the top. So I think in the long run, there will be no difficulties.

Senator SMITH. Thank you very much, Mr. Chairman.

I am sorry I have to leave.

Senator STENNIS. Well, you have these special duties on the floor, and we would be glad to have you return when you can.

Senator Young, you are recognized for 10 minutes.

WE CAN EXPECT THE RUSSIANS TO DEVELOP ROCKET BOOSTERS WITH GREATER THRUST

Senator YOUNG. I believe I just have a couple of questions, Doctor.

Doctor, from the chart and from your testimony, we note that the first operational firing of the Saturn is expected early in 1964.

Dr. VON BRAUN. That is correct.

Senator YOUNG. And you testified about the tremendous thrust capability that that will have in 1964. Now, what is your judgment as to the thrust capability that the Soviet Union will have at that time with a comparable booster?

Dr. VON BRAUN. Sir, I think we can expect that the Russians are also busy developing booster rockets with a greater thrust capability. But I think, with a vehicle of the size of the Saturn, we have reached a point where at least temporarily the rocket can offer the payload man so much in terms of transportation that there may be a period where the payload man has the major problem in his hands to fill all this space with something useful.

For example, when we are able to provide a vehicle capable of carrying several people in orbit, we will need an extensive period of time, probably, to develop what you might call manned orbital operations. This is strictly virgin territory. Nobody has ever been out there. It will be very difficult to predict whether this work will go as smoothly and on schedule as the development of hardware like these rockets. For that reason, I believe that after vehicles of the size of the Saturn are available there will be a period where the emphasis in space capability will be less in the weight-carrying capability and more in other fields. Only after the payload people and particularly the man-in-space experts have caught up with their problems will there be a need for a still greater payload capability.

FUTURE EMPHASIS WILL SHIFT TO FACTORS OTHER THAN THRUST

Senator YOUNG. We understand from that, then, that in your judgment, in 1964, there will really be no reason why the Russians should have a thrust capability beyond our own plans?

Dr. VON BRAUN. Well, to rephrase my answer, sir, what I mean is: Suppose the Russians have the same thrust capability in 1964 as we have—in other words, that they also have a launch vehicle the size of the Saturn. The importance of our position relative to that of the Russians will probably then be in how well they handle orbital operations as compared to us.

The emphasis will be off the weight-lifting capability, and on other factors in the space program.

Senator YOUNG. And is it your prediction, then, Doctor, that the Russians will not exceed our thrust capability after 1964?

Dr. VON BRAUN. I think in the long haul both we and the Russians will want to have launch vehicles even larger than Saturn.

Senator YOUNG. Well, in your judgment, if we provide the funds that you now seek and that policy continues in the Congress, is there any reason why the Russians should exceed us after 1964?

Dr. VON BRAUN. Sir, we have a program within the National Aeronautics and Space Administration for a vehicle much larger than Saturn. We call it the Nova concept, right now. Only the engine portion is under active development.

This engine has a capability of 1.5 million pounds of thrust in a single barrel, and these can be clustered. This Nova vehicle will ultimately be able to carry much more payload into orbit, or to the moon, than Saturn. But we feel we will need several years of hard work to develop techniques before we can intelligently utilize such a much greater orbital capability.

Senator YOUNG. Well, Doctor, late yesterday Dr. Glennan testified right here before this subcommittee that the first operational Saturn is expected to be launched in 1964. That coincides exactly and precisely with your testimony. And then Dr. Glennan stated in addition to that that he doubted that the Soviet Union will exceed us in thrust capability after that time.

Now, do you agree with that prediction?

Dr. VON BRAUN. Sir, I would consider this is a very sound and well-founded estimate, mainly for the reason that the Russians may find it less attractive to concentrate on much more than this thrust level, for the reasons I just mentioned. In other words, there will be many other problems on which they may want to concentrate. They, too, are confronted with the secrets of Nature, and will have to overcome some of these fundamental difficulties.

For that reason, I share Dr. Glennan's views completely.

WE ARE NOT TAKING THE RUSSIANS SERIOUSLY ENOUGH

Senator YOUNG. Well, now, Doctor, earlier this month in a Sunday feature article, newspapers carried an article written by you, relative to the conquest of space. And in that you made this statement, "It is later than we think, and our position in the world is gravely in danger."

Now, are there any recommendations in addition to the ones you have already given us that you would make to meet and overcome this danger?

Dr. VON BRAUN. Sir, this particular remark referred to our position vis-a-vis the Soviet Union in general, on the broad national front, and it was not in any way limited to booster payload capabilities, or rocketry, but included things such as the number of engineers that we graduate per year, and the number of scientists that we produce, the level of educational effort, the rate of progress in many fields of engineering. This is what I was referring to in the context of this article.

Senator YOUNG. And you have no additional recommendations at the present time, then?

Dr. VON BRAUN. Well, I believe that I can say only in very broad terms that we are confronted with an opponent who has a peacetime econmy on a wartime footing, and I think in some areas we may not be taking them seriously enough.

Senator YOUNG. So our position is endangered, and you feel that the American people should regard the situation more seriously than they have?

Dr. VON BRAUN. I am convinced of this, yes, sir.

Senator YOUNG. But on your part, you are doing your utmost, are you not?

Dr. VON BRAUN. Yes, sir.

Senator YOUNG. And at the present time, you feel that we of the Congress have provided you with sufficient means?

Dr. VON BRAUN. Yes, sir.

Senator YOUNG. Thank you.

VON BRAUN ARTICLE PLACED IN RECORD

Senator STENNIS. Gentlemen of the committee, the article mentioned appeared in the Sunday magazine section This Week by Dr. von Braun, entitled "Why Should America Conquer Space?" It has a down-to-earth practical feel to it, and I feel it is of value. Without objection, then, we will place that in the record at this point.

(The material referred to is as follows:)

WHY SHOULD AMERICA CONQUER SPACE?

(By Wernher Von Braun, Director, Development Operations Division, Army Ballistic Missile Agency)

In one of the most inspiring articles on the subject you will ever read, a man who has dedicated his life to the conquest of space explains simply and fully what space means to our future.

HUNTSVILLE, ALA.

When we speak of the "conquest of space" we had better clarify that term right at the outset. For one thing, we do not mean conquest in the sense of beating little green men into submission and staking out a nationalistic claim on the universe. Also, space is a pretty big place—they say it is even bigger than Texas and Alaska thrown together.

Not even the boldest science fiction writer would ever dream of earth men exploring all the space from here to infinity. When we speak of conquest of space we mean no more than visits to a few of our close celestial neighbors. Nevertheless, some of these neighboring stars may be just as intriguing and just as full of mysteries as our own little planet which until the dawn of the space age we called the world.

No matter how limited his objective, man's conquest of space is the boldest venture he has ever embarked upon. Since time eternal the force of gravity has chained him to the earth's surface. Half a century after man learned to build flying machines whose wings could temporarily overcome his weight, science and technology are ready to give him the means to soar above the atmosphere and shake off the chains of gravity altogether.

Why must we take up this challenge? Why must we conquer space now that we have the technical ability to do it?

Dr. James R. Killian, the President's former scientific adviser, gave as the main reason "the compelling urge to explore the unknown." Throughout the history of human progress this urge has motivated not only heroic men of action like Columbus or Peary, but also penetrating thinkers like Ptolemy and Einstein. Just plain curiosity has always been a far more effective mainspring for research and exploration than hope for economic returns.

All our modern conveniences had their origin in research which was carried out without regard to practical application and merely because some man wanted to know the how and why of the universe. The automobile, the airplane, our electrical miracles, the clothes we wear, the food we eat, the glasses we use—all are the direct outgrowth of scientific research conducted out of man's innate curiosity.

Because an obscure Austrian monk, experimenting with white and red peas in a corner of the monastery garden, was curious about the statistical results of his crossbreeding tests, man has learned to grow hardier corn and raise sturdier cattle to feed the hungry millions.

Because a 20th century bacteriologist was curious about certain physical reactions taking place in plain mold, we have penicillin.

Even the most formidable and fateful discovery of our time, thermonuclear energy, was made only because a few men wondered what prevented the Sun from losing its heat as rapidly as its tremendous continuous energy losses through radiation would seem to suggest.

The trouble about contemporary research begins when the "compelling urges to explore the unknown" felt by representatives of the many disciplines of science begin to compete for the tax dollar. Sometimes we have some real soul searching to do. Take the question of rocket research versus medical research. Just a few months ago my mother died of cancer, so when I ask myself whether, say a hundred million dollars of taxpayers' money would be better spent on cencer research or on an attempt to take a few pictures of the far side of the Moon, I hesitate to give an answer.

But am I asking myself the right question? Surely there is another aspect to the problem. Suppose everything America stands for in the eyes of the world could be expressed in terms of a stock market rating of so many hundred billion dollars. Supose further that the fact that the Soviets succeeded in photographing the Moon's unseen side reduced that rating by a faction of 1 percent—say $1 billion. When I now assure you that for one-tenth of that amount America could have done the same thing ahead of the Russian's Lunik III, don't you think we can argue it would have been a worthwhile investment?

Whether we like it or not we are engaged in a worldwide popularity contest with the Soviets. We are competing for allies among the many have-not nations for whose underfed multitudes the Communist formula of life has a great appeal. We are seeking friends among the many small countries, rich or poor, which would like to remain outside the powerful magnetic field lines arching from Washington to Moscow, but which in a world of jet travel and intercontinental rockets often have no choice but to side with a richer and mightier partner.

A feat like that performed by Lunik III is tantamount to a lost battle in that silent, cold struggle for the hearts of the "uncommitted." And Lunik II (which planted the hammer and sickle on the Moon) was another lost battle, and Lunik I (which first went into oribit around the Sun) was still another. And the series of sputniks which opened the space age were still more lost battles. We are now moving into a more affirmative position in the cold war, by which to win the hearts and the hopes of the uncommitted.

I do not think we can dismiss this grim competition as a weight-lifting contest between rival rocket teams. When the whole world sits in the audience and the heavens are the stage, pride and prestige are real issues and serve ends which are vital for our Nation's role in the world of men. I just don't believe the American people are ready to concede that they have lost their frontier spirit—just as we enter the struggle for man's last and limitless frontier. I am not ready to believe that America is willing to surrender the heavens to the Reds.

The other day I was giving one of those after-dinner speeches which rocket men seem to be unable to duck in these times. I sounded what I thought was a ringing appeal for a determined U.S. space program and got a big hand. During the ensuing question-and-answer period someone got up and demanded: "Why are you telling us all that? Weren't you connected with the development of the Nazi V–2 rockets that fell on London during the last war?"

All I could answer was that having survived one dictatorship I didn't want my own American-born children nor anyone else's to live under another. Maybe I should have said it seems that you must have passed through purgatory to appreciate heaven.

This would not have been an oratory statement either. It is a source of never-ending surprise for me, how the vast majority of native-born Americans take their cherished liberties for granted, as something they don't have to struggle for. And somehow, I am profoundly worried as to what has happened to the American frontier spirit.

I spent my first 5 years in this country in El Paso, Tex., where "the law west of the Pecos" is still vividly remembered. But during the succeeding years of postwar readjustment of the U.S. economy I have read more and more about labor-management arguments, about higher wages and shorter hours, about trends toward more distraction for youngsters and less study, about a rosy future of leisure and comfort. I have also read, often in the same papers, about completely unexpected Soviet A-bomb tests, about China going Communist, and about Russian rockets accomplishing things that the United States was unable even to repeat.

During my 15 years in the United States I have seen and learned to love so many endearing things about this country and its people that I have to almost force myself to a critical remark. America is not only the richest and technically most advanced country in the world, but also the one where people laugh and enjoy God's world more than anywhere else. But in their constitutionally guaranteed pursuit of happiness many Americans seem to refuse to look at the dark clouds which are rapidly moving up. I fear it is later than we think, and our position in the world is gravely endangered.

During the last war, while I was on the other side, Winston Churchill told his hard-pressed countrymen that all he could offer them was blood, sweat, and tears. I concede that in an election year blood, sweat, and tears make poor campaign slogans. But I think the Soviet space challenge is serious enough to warrant some serious thought. Only a few weeks ago Walter Lippmann wrote: "The voices that will serve this country, and indeed save it, will be those of stern men demanding hard things. They may not yet do as well in the Gallup polls. They will be listened to sooner or later. For they will shatter the belief, now so prevalent among us, that affluence is greatness. It is not. In the history of human society, it has not seldom been the case that when riches were devoted to luxury, it was the mark of their decline."

Space lies out there like a vast, unexplored ocean—accessible to all nations large or small, a challenge for anyone with sailor's blood in his veins. Now that for the first time in history man is about ready and able to build ships which can penetrate that ocean, there can be no question that some men will take up the challenge. Some of them will make great discoveries out there, and some of these discoveries will greatly affect the course of history on our home planet. Shall we exclude ourselves from this contest because we prefer to "devote our riches to luxury?"

Our competitor in this cosmic contest is tough. His peacetime economy is on a wartime footing, and with great consequence and at great sacrifices in the area of badly needed consumer goods he applies his resources to efforts he deems essential in the overall national interest. The Russian scientists with whom I have talked left no doubt in my mind that their space exploration program not only has been given highest national priority, but that it is also conducted with great competence, enthusiasm, and devotion. We are confronted with a formidable competitor in this difficult field and it would be a disaster if we underrated his ability and determination.

Some people want to know whether space exploration will ever pay off. I am convinced it will, but it is not so simple to provide the unfaithful with ironclad proof. One can quote historical examples, such as Columbus' exploratory voyage, which obviously did pay off. One can point to such potential money-making space projects as radio and television relay satellites for worldwide communication. But one cannot put a price tag on such a discovery as the great Van Allen radiation belt which was found with the aid of some of our early scientific satellites, and which may prove to be of utmost practical importance for many things on Earth.

We have just opened the door into the limitless reaches of the universe and we can see just far enough ahead to know that man is at the threshold of a momentous area. Here is opportunity, challenge, adventure so tremendous as to exceed anything which has gone before. Here is the tomorrow which youth wants to embrace, and which we must not deny because of a waning of the frontier spirit which made America great.

Within a few decades we can have the means to send large expeditions out into the solar system, to Venus, Mars, and beyond. From their explorations of our neighborly planets these expeditions will bring home a wealth of new scientific insight which will exceed some of our fondest expectations.

It is impossible to predict the nature of all these discoveries: their cumulative effect will be tantamount to a scientific revolution. But it will also be a revolution of human perspective, and here may be space flight's most far-reaching payoff. We need not fear that future space explorers on their heaven-storming journeys will lose their humility. The heavens will surround them as an eternal reminder that there is a force greater than the thrust of their rocket ships, a spirit greater than the cold logic of their computers, a power greater than that of their own nation.

Senator STENNIS. Thank you, Senator Young.
Senator Martin, you are recognized for 10 minutes.

HUNTSVILLE WILL BE RESPONSIBLE FOR MULTISTAGE SPACE VEHICLES

Senator MARTIN. Dr. von Braun, I understand from your statements this morning your organization at Huntsville will be responsible for the development of big boosters. Is that your sole responsibility in this new organization?

Dr. VON BRAUN. Sir, we are responsible for complete multistage rocket systems, capable of imparting sufficient speed to a payload, to the point where it goes into orbit or transfer, to a moon trajectory—so our responsibility is not limited to the first stage which we usually refer to as the booster, but to the entire multistage vehicle, with the exception of its payload.

Senator MARTIN. I am very much relieved by your comments in reply to Senator Smith a few minutes ago, that there hasn't been any large number of your staff who have resigned. I believe you said there were only three?

Dr. VON BRAUN. Yes, sir.

Senator MARTIN. And they were in a special field not directly part of your big booster development program?

Dr. VON BRAUN. That is correct, sir. Now, as we go along with some of our readjustments, there may be a few more in some areas. But I think this is caused by our readjustment to the new assignments. We were not originally cut out to be nothing but a booster agency. We had penetrated all kinds of other fields also. But I think now that this is our assignment, there is nothing wrong with a few personnel readjustments. It is only natural.

Senator MARTIN. Your reassurance at this point is very important to us on this committee.

THE NOVA CONCEPT IS BEING CLARIFIED

Are you making any plans this early for the development of the Nova? You mentioned that a moment ago. Using the F–1 engine? Are you working on that now?

Dr. VON BRAUN. Yes, sir. We have been assigned the job to first clarify the Nova concept. So far, as I pointed out, only the engine is under active development. There is a contract with Rocketdyne in Los Angeles to develop this 1½ million-pound rocket engine. But the exact design details of the Nova vehicle have not been clarified yet.

It is, of course, simple to just draw up a scaled-up version of the Saturn and say this is Nova. But this is not the way we propose to go about this, because the chances are that by the time you have this new rocket engine available, technology in other fields will have made great advances also, and we would like to make sure that whatever we choose as upper stages is really the most modern equipment available under the state of the art at that time. This, of course, is quite an involved operation—to make a sober estimate as to what upper stages could be available by the time we have that engine. That is what we are doing at the moment in the Nova field.

Senator MARTIN. What role will your group play in the development of nuclear-powered boosters?

NUCLEAR POWERED ROCKETS MAY COMBINE WITH NOVA BOOSTER

Dr. VON BRAUN. Sir, this ties in somewhat with the Nova program. One of the problems under consideration is whether or not one should not combine nuclear upper stages with a Nova-type booster. This makes a very attractive vehicle.

On the other hand, nuclear rocketry is still in the beginning. At the moment there is an agreement between NASA and the AEC as to how this program will be conducted. In essence, it amounts to this: Right now we need more knowledge on fundamentals, such as heat transfer, high temperatures, reactors, material problems, and the like.

This knowledge will be provided basically by AEC. NASA will assist them, and will also be investigating what we ultimately want to get out of nuclear propulsion when we make a vehicle out of it. Chances are that in 2 or 3 years the shoe will be on the other foot; there will be much basic knowledge available in the field, and the emphasis will be on the vehicle itself. I think there is a certain similarity in the nuclear submarine development. Early in the program, the emphasis was on the design of reactors that could be used to generate steam so you could run a turbine on it. There was a lot of supporting research necessary to create the knowledge to build something like this.

Finally, the state of the art permitted the tackling of a nuclear submarine project, and at that time the emphasis shifted to the submarine people and the reactor was only a component shipped to the shipyard.

Senator MARTIN. There is no reason why you cannot anticipate similar cooperation and development in close working relationship with AEC.

Dr. VON BRAUN. Such a cooperation exists already and there is a joint NASA–AEC Committee to do just that. This works very smoothly on the working level.

Senator MARTIN. I appreciate your reassurance on this point, because it is important to us also.

That is all, Mr. Chairman.

Senator STENNIS. All right. Thank you, Senator.

Senator Cannon?

VON BRAUN TEAM WILL FINISH UP PERSHING BUT WILL UNDERTAKE NO NEW MISSILE PROJECTS FOR ARMY

Senator CANNON. Thank you, Mr. Chairman.

Doctor, relating to your statement about the building problem for the Army Space Laboratory program, is this a result of additional space needed, or as a result of the fact that you are no longer under the Army, and the Army wants their own building?

Dr. VON BRAUN. No, sir. I think it is simply caused by this:

Our division used to represent a space capability, which NASA was interested in, and at the same time it used to represent a certain missile capability, in which the Army was interested.

The Army, of course, needs a continuing capability in the missile area, and has a build up this capability again. We are helping them by transferring certain cadres out of our organization to the Army, to provide at least a skeleton around which this new Army organization can be built. But there will be more personnel employed in Redstone Arsenal as a whole after the separation.

Senator CANNON. In other words, they will have to build up a staff and a capability to do certain work that you were doing for them before?

Dr. VON BRAUN. Yes, sir; on a somewhat reduced scale. The Army plans to do less inhouse work in the future and do more with contracting. But the Army still needs a missile capability. I think in the atomic age, the nuclear age, an Army without missiles is just not thinkable.

Dr. CANNON. Now, is that a capability that your organization could still not conduct for them, and at the same time carry on your present assigned mission?

Dr. VON BRAUN. Sir, we are committed to finish up the Pershing missile system, because it was considered unwise on both sides of the fence to change horses in midstream. But we will not take on new missile projects for the Army. And there will be others after the Pershing. This is a fast-moving art, and you cannot afford to stand still.

Senator CANNON. Well, I don't think that quite answers my question. What I am trying to find out is whether your organization could continue to do the job for the Army and take care of your present assigned mission simultaneously, or do you have too much to do with your present assignment so that you could not carry on the problems that you have been carrying on for the Army in the past.

Dr. VON BRAUN. We have too much to do to carry out what NASA asks of us.

VON BRAUN CONSIDERS WE ARE IN SPACE RACE WITH RUSSIANS

Senator CANNON. Thank you, Doctor.

Now, yesterday Dr. Glennan said that we were not in a race with the Russians, because we didn't know what track they were running on, and we don't know what their next objective is going to be.

Do you agree that we are not in a space race with the Russians at the present time?

Dr. VON BRAUN. I fail to see the difference between a competition and a race. I think for the man on the working level it is very much the same thing, he just has to work as hard as he can.

Senator CANNON. Actually, it is just a question of semantics. Actually, Russia is ahead of us in many areas, and we are desperately trying to overtake them and get ahead of them in some of these related areas. Is that a fair statement?

Dr. VON BRAUN. In the large payload carrying capability; yes, sir, this is correct.

Senator CANNON. Now, Doctor, while we may not know exactly what the Russians have in mind to do next, is there any doubt in your mind that they have a set of specific objectives of things they intend to do?

Dr. VON BRAUN. Well, they have announced some of their plans publicly. I think we would be well advised to read up on what they announced, because sometimes it is amazing how well they live up to their own announcements. For example, they have definitely announced that they have a man-in-space program. So far, to my knowledge, they have not tried to put anyone in orbit, but I think they are——

RUSSIAN OBJECTIVE IS TO PUT MAN ON THE MOON

Senator CANNON. You think, for example, they are planning to put a man on the moon? Do you think that is one of their objectives?

Dr. VON BRAUN. I do not think they will try that without intermediate steps, but I am convinced that it is their objective ultimately.

Senator CANNON. In view of their present lead, do you feel there is a chance we might beat them in placing a man on the moon, or do you think they are too far ahead of us?

Dr. VON BRAUN. Sir, despite all our miniaturization that we are so proud of, we shouldn't overlook the fact that you cannot miniaturize a man. So in that area, a larger rocket, of course, is helpful. On the other hand, our Atlas missiles are powerful enough to carry at least one man in orbit. That is what Program Mercury is doing.

Senator CANNON. I don't want to unduly press you, but my question was do you think there is a chance we might beat them in placing a man on the moon?

Dr. VON BRAUN. Sir, this question is difficult to answer, because in this field you cannot take shortcuts, unless you are willing to take a greater risk. We are definitely not willing to take such shortcuts, because we feel it is wiser to complete one step after another. Whether the Russians are willing to take such shortcuts, I do not know.

Senator CANNON. Well, obviously, they are now ahead of us in some requirement areas, for example, in more powerful rockets. And I am wondering if you think they would have to take any shortcuts, in order to be able to beat us in that area?

RUSSIANS COULD PUT MAN IN ORBIT AROUND THE MOON TODAY

Dr. VON BRAUN. Well, let us take one example. I think the Russian payload capability would permit them to send a man around the moon today. Their Lunik III carrier probably was powerful enough to do that. Whether they can retrieve the man after he returns remains to be seen. I think with the present state of the art, this would be a very risky affair. But if they are willing to gamble on success, they may do it. They may, of course, be able to cash in another propaganda victory by having a man report what he saw on the far side of the moon, even if the man doesn't survive, and still announce his findings before he is lost.

Senator CANNON. It certainly would be another first for them, if they did that.

Dr. VON BRAUN. Yes. I think their thrust capability is adequate to do that right now. Ours probably is not.

WE ARE 10 YEARS FROM MANNED LANDING ON MOON

Senator CANNON. On the basis of our present program of funding, do you think they will likely get a man to the moon before us?

Dr. VON BRAUN. Sir, I believe a landing on the moon is far more involved. Even the Saturn can do it only with orbital refueling, and I do not believe that the Russians have today a capability to do that. We are at least 10 years from a landing on the moon, and so are they, in my opinion.

Senator CANNON. In other words, as far as time is concerned, you think we are about the same time away from placing a man on the moon?

Dr. VON BRAUN. Yes. I believe it is a question of emphasis, what is considered the most important program, and also how many shortcuts you are willing to take.

Senator CANNON. The reason I am asking questions along this line, last year you said that in your opinion the Russians were 5 years ahead of us in this field, and that meant that they were 5 years ahead of us, and that we could close the gap in 5 years, assuming that they were to stand still. And certainly we recognize that they would not continue to stand still. Do I correctly recall your testimony that that was the substance of it?

RUSSIANS ARE AHEAD IN BOOSTER DEVELOPMENT AND PAYLOAD CAPABILITY

Dr. VON BRAUN. I always referred to booster development and payload capability. I was asked when we could fire a man around the moon and back. It will still be several years off in our case. I think the Russians would be ahead in this field today.

Senator CANNON. Now, yesterday Dr. Glennan stated there was no question but what we would eventually catch the Russians. I think he was probably relating that to the big boosters. But since they are now ahead of us, this would mean actually we would have to be progressing at a greater rate than they are and I am wondering if you think we are, today, progressing at a greater rate than the Russians are.

Senator STENNIS. Is that on the moon project?

Senator CANNON. In the general space field.

SCIENTIFIC VALUE OF OUR SPACE EXPERIMENTS EXCEEDS THAT OF RUSSIA

Dr. VON BRAUN. Well, sir, I believe if we look at the space field as a whole, it looks a bit different. There are, as I pointed out, certain areas where we may even be ahead of them. For example, I think the scientific value of all our satellites and space probes combined probably exceeds the value of their experiments. We have published more. And I think that the consensus of opinion in the international scientific community is that the American space satellites have produced more scientific knowledge than the Russian ones. But in other fields—payload capability in particular—we are behind. And, as I said, we cannot speed up the Saturn faster than this accelerated program. It would be operating beyond the point of diminishing returns to do that. This is about as fast as we can move.

Senator CANNON. What about the guidance area? Would you say

that we have demonstrated any better or as good a guidance capability as the Russians have?

Dr. VON BRAUN. They have demonstrated that they are very competent in the guidance field. Our capability in the guidance field is certainly good enough to hit military targets with an ICBM. So I think both theirs and our demonstrated guidance capabilities are adequate for the job today.

Senator CANNON. So either we or they have a relatively comparable guidance system?

VON BRAUN DOES NOT KNOW WHAT RUSSIA IS DOING IN THRUST DEVELOPMENT

Dr. VON BRAUN. Yes, I think we are comparable.

Senator CANNON. Then, actually, it would boil down to the fact that at this time they have a greater booster capability, and therefore they have a greater payload capability. And in the guidance field we are roughly equal. And, as I understand your answer to Senator Young, you apparently agree with Dr. Glennan that after or by the end of 1964 we will probably have as great a thrust capability as they will have at that time. But would it be fair to assume that they may be ahead of us in certain other areas, because they are now ahead of us in the thrust capability?

Dr. VON BRAUN. Not knowing what they are doing, sir, I am reluctant to answer that question.

Senator CANNON. Well, you know what they have done in the past. You have been very fair to admit here today that they have made a lot of statements that have proven to be true. And based on what they have done, and comparing that to what they have said they were going to do, I wonder if you would care to express an opinion?

Dr. VON BRAUN. Sir, I believe, if I may express myself in somewhat more general terms, that the NASA space program, including both the vehicle area and the payload and mission area, is a well-conceived and logical program where no particular area is neglected in favor of another. In other words, we are moving along on a pretty broad front.

Senator CANNON. You feel that we are now doing everything we should be doing in this particular field?

Dr. VON BRAUN. Yes.

WE ARE NOT DOING ENOUGH IN EDUCATING ENGINEERS AND SCIENTISTS

Senator CANNON. Now, you answered Senator Young in a manner that disturbed me a minute ago, when you said that in some areas we may not be taking them seriously enough. What areas did you refer to? What did you mean by that?

Dr. VON BRAUN. Sir, I believe in the space area we are now taking them seriously enough, in that we have almost a billion dollar program going in 1961. And I think it is a well-adjusted and sound program. In other words, we are doing enough in the man-in-space area, we are doing enough in lunar and planetary exploration, and in booster development, and so forth. I think it is a well-rounded program. We are definitely deemphasizing the spectacular. So in this respect, I think we are in good shape. I think there are many other fields.

In this article I referred to the broader question of our overall stature—for example, the educational field, where I just feel we are not doing enough in preparing the next generation of scientists and engineers to cope with their Russian counterparts. We are just producing too little. Our courses are too soft. We are spending too much time in nonessentials. That is what I mean.

Senator CANNON. Would you say, then, that generally you are in agreement with the public statements that Admiral Rickover has made in relation to our educational program and the Russian educational program?

Dr. VON BRAUN. Yes, sir.

Senator CANNON. Would you say that is one of the main areas that you think we are not taking them seriously enough?

Dr. VON BRAUN. Yes, sir.

Senator CANNON. Would that be your No. 1 area in which you think we are not taking them seriously enough?

Dr. VON BRAUN. Well, defense, in general, is another area.

Senator CANNON. You think we are not taking them seriously enough in strengthening our own defensive capabilities?

Dr. VON BRAUN. Yes, sir.

Senator CANNON. And what other areas?

WE SHOULD BE DOING MORE FOR DEFENSE OF UNITED STATES

Dr. VON BRAUN. To put it in a very simple formula, if I personally had a choice of spending a little more money on taxes to buy a safer future for my children, I would rather do it than have a second car.

Senator CANNON. In other words, you would recommend taking out a little insurance?

Dr. VON BRAUN. Yes. I think we should be willing to bear a greater sacrifice for our future status and our future security and safety vis-a-vis the Russians, plus the Chinese, and tighten our belts a little bit so that our children will be better off.

Senator CANNON. Would it be fair to say, then, that based on what you know of these people, and what you have seen them accomplish, and what they have said they are going to accomplish, that you think we are not doing enough at the present time?

Dr. VON BRAUN. I am convinced of this.

Senator CANNON. In the educational and in the defense field to provide for the safety and security of this country?

Dr. VON BRAUN. Yes, sir.

Senator CANNON. Thank you very much, Doctor. I think you have made a very fine contribution. And I want to compliment you on it.

Senator STENNIS. Thank you, Senator.

GOVERNMENT MUST HAVE ADEQUATE "IN-HOUSE" CAPABILITY TO RETAIN COMPETENCE

Doctor, I have a few more questions here to cover some of the budgetary items.

Now, I think you have already covered your personal and facilities items down at Huntsville. I want to ask you a few questions now about what you call the inhouse capabilities at Huntsville compared with the work to be done by private contractors.

What do you consider the proper relationship between the work that you do yourself—sometimes called the arsenal concept, or inhouse capability—and the work that is done by private contractors? Explain briefly to us what your philosophy is concerning this relationship.

Dr. VON BRAUN. Sir, we have broken down our budget figures in great detail. This breakdown shows that about 80 percent of our money winds up in the hands of contractors, actually it is even a little more than 80 percent.

Senator STENNIS. So, volumewise, 80 percent of your dollars go into the private contractor channels?

Dr. VON BRAUN. It goes into private industry, to buy either complete upper stages, or complete radio receiver systems or rocket engines for the booster, or just material—sheet metal, tubing, plumbing, and so forth.

But we believe that in a field as complicated as the development of large missile systems, it is absolutely necessary for the Government to have the certain inhouse competency to make a sound decision as to where and in what areas taxpayers' money should be spent.

It is a very embarrassing situation when the Government employee, who has to evaluate a contractor's proposal, is not competent enough to judge which of these proposals is most attractive, which is sound, and which is hopelessly underestimated as far as funding needs, or is unsound from the planning point of view, and so on.

I think it is necessary to have an adequate competence on the Government payroll to decide where the tax dollar should be spent in industry.

Now, the question of inhouse work is very closely related to this, because it has been our experience that you cannot retain in the long run an inhouse competence unless you do a certain amount of work there yourself. You have to keep your judgment sharpened by giving the Government scientists and the Government engineers an opportunity to burn their own fingers, so that they can really talk as experts to the industrial experts.

If you don't do that, and reduce the Government employee to solely a procurement man who just analyzes what he is told, then his judgment will have soon been blunted. And our experience has been that if he is a really good man, he winds up on the company payroll, because he feels that that is where the interesting work is being done. Soon you find yourself without any Government capability.

Senator STENNIS. Well, I think you have made a very clear explanation of that, and brought out some very strong points, too.

Now, one question on Nova.

NOVA WORK CURRENTLY LIMITED TO CONCEPT STUDIES

Will you do as much hardware assembly with reference to Nova, test work and all, as you are doing on Saturn?

Dr. VON BRAUN. So far there is only one area where hardware development for Nova is going on, and that is the engine contract for the 1½-million-pound thrust rocket engine at Rocketdyne. Our own work in the Nova area so far is limited solely to concept studies, which are paper studies. For example, how is the Nova booster mated with

a nuclear rocket—what payload capability does it offer, what problems would it raise, how large would it be, et cetera.

I think we will be tied up for quite awhile with Saturn, so for years to come we could not conceivably take any actual hardware work for Nova into our Huntsville facility.

How this situation will look 8 years or so from now, when Nova vehicles will be actually built is hard to say. I could envision that we may want to bring some of that hardware through our facilities and check it out. There is a great question, however, whether even a captive test stand for the Nova booster could be operated in Huntsville, because of the noise difficulties. I have my great doubts that this can be done——

I do not envision Nova boosters being fired at Huntsville.

NO APPRECIABLE FUTURE INCREASE IN FACILITIES CONTEMPLATED AT HUNTSVILLE

Senator STENNIS. Going back for a moment to this new building down in Huntsville, after the budget year 1961, can you now foresee any further appreciable expansion in your facilities or personnel at Huntsville?

Dr. VON BRAUN. No, sir; our personnel level on the Government payroll is more or less frozen.

Senator STENNIS. All right; what about new buildings? Will you need an appreciable number of new buildings?

Dr. VON BRAUN. No, sir——

Senator STENNIS. In the foreseeable future?

Dr. VON BRAUN. As far as 1961 is concerned, we have lumped all of our construction requirements together, and I think it is something like $54 million.

Senator STENNIS. All right; we can tell the Senate then, if the inquiry is made that this represents your program for the foreseeable future, is that correct?

Dr. VON BRAUN. Sir, there will be some smaller amounts——

Senator STENNIS. I know, small items excepted, this is your major construction program, is that correct?

Dr. VON BRAUN. That is correct, sir; yes.

HAMPERING OVERTIME RESTRICTIONS ON SATURN HAVE BEEN LIFTED

Senator STENNIS. All right; now, going to another subject, in the President's letter of January 14 of this year to Dr. Glennan, he authorized the use of such additional overtime deemed necessary on the Saturn project. Now, were your operations hampered by restrictions on overtime while you were under ARPA and Army jurisdiction?

Dr. VON BRAUN. Yes, sir, for several months we could not work overtime at all for lack of funds.

Senator STENNIS. I was down in Huntsville, and saw you there in December of 1959, and it was very apparent then—you could feel it—that you were hampered. It seemed to me you were hampered for the lack of the overtime.

Now, you have gotten your restrictions removed on that, and that improves the situation, is that correct?

Dr. VON BRAUN. Yes, sir; we are using overtime, not across the board, but at our discretion in areas where it is necessary in order to

speed things up. For example, test stand work is one of these areas.

Senator STENNIS. You are given authority to use your own discretion as to where you apply the overtime?

Dr. VON BRAUN. Wherever needed; yes, sir.

Senator STENNIS. And you do have enough money to take care of it?

Dr. VON BRAUN. Yes, sir.

SATURN CONSIDERED ONLY BOOSTER AVAILABLE FOR DYNASOAR PROGRAM

Senator STENNIS. All right; you have referred to the Saturn as being the rocket booster for the Dynasoar. Now, the Department of Defense states that no determination has been made of what booster will be used beyond the Titan. Are you in any way compromising the design of Saturn to be the booster for Dynasoar, even though it hasn't been selected and may not ever be selected to do so?

Dr. VON BRAUN. Sir, this is again, I think, a question of semantics. The Dynasoar program as presently envisioned by the Air Force will be carried out in several phases. The first phase will be models that will be flown, unmanned. The first manned flights with Dynasoar are planned with the Titan. But, there is a third type of a Dynasoar which will be of some military significance, and it will certainly be a larger vehicle. For this, the Saturn is the only boost vehicle presently under development that could do the job.

We have an Air Force officer on the Saturn staff who provides the necessary inputs from the Air Force to the Saturn program. But the entire Dynasoar project at the moment is under reevaluation by the Air Force, so it is lack of input from their end that prevents us from being any more specific in this area.

We have not compromised the Saturn booster design because of any Dynasoar requirements because nobody was in a position to spell out exactly what the ultimate Dynasoar will look like.

Senator STENNIS. Very well.

Doctor, is there anything else you wish to say now about any point we have not brought up?

Dr. VON BRAUN. No, sir.

THERE IS EVIDENCE OF RUSSIAN MISFIRINGS

Senator MARTIN. Dr. von Braun, have you heard of any Russian failures in the field of propulsion?

Dr. VON BRAUN. Sir, I think there is some evidence available that the Russians had some misfirings, also.

Senator MARTIN. Has that been widely publicized?

Dr. VON BRAUN. I do not think so; but there is evidence there.

Senator MARTIN. That is all.

Senator STENNIS. Thank you, Doctor.

Senator Cannon?

Mr. Lehrer, do you have any questions now for the doctor, before we conclude?

Dr. VON BRAUN. Sir, if I may answer Senator Martin a little more in detail—I didn't mean to duck your question.

Senator MARTIN. I want to ask this additional point: Is there any significance in your mind in the lack of publicity of Russian failures?

Dr. VON BRAUN. Well, this has always been their policy, that they don't announce their failures. I think the simple answer is that they don't need public support of their program to the extent that we do.

Senator MARTIN. We are clearly ahead of them in that field?

Dr. VON BRAUN. Sir, I think if you are to get public support in this field, you have to tell people not only the good things but also the bad ones, so that people realize that success doesn't come easy in this field.

Senator MARTIN. I have collected extensive clippings in this field personally for the last 2½ years. I have quite a file of clippings on American failures. And I don't have any clippings on Russian failures.

Dr. VON BRAUN. Sir, I think the information on Russian failures is available, if the question was asked in closed session.

Senator MARTIN. It is not likely, is it, that every experiment of theirs is a success?

Dr. VON BRAUN. No, sir.

Senator STENNIS. Thank you, Senator.

All right, Dr. von Braun. Mr. Lehrer has a few questions.

FAILURE TO PROVIDE ADDITIONAL FUNDS IN 1960 HAS DELAYED SATURN SCHEDULE BY 6 MONTHS

Mr. LEHRER. May we clarify one thing, Dr. von Braun? Last December at Huntsville, you discussed with Senator Stennis and the committee staff the difference between the program which you had advocated last year for Saturn and that which is currently approved; namely, last year you had advocated approval of $127 million for fiscal year 1960 and $250 million for fiscal year 1961. The currently approved programs calls for $71½ million for fiscal year 1960 and $230 million for fiscal year 1961. Now, on the charts which you showed here today, you indicate that the $230 million for 1961 cuts 1 year from the time of the test firing over the previously approved program of $140 million.

Would you please tell us what the relationship is between the current firing schedule of Saturn, based on the $71½ million funding for fiscal year 1960 and the $230 million funding for fiscal year 1961 and the firing schedule we would have had if your recommendations last year for $127 and $250 million, respectively, had been approved?

Dr. VON BRAUN. There is no question that due to the fact that we did not receive the balance of almost $60 million in 1960, at the time we asked for it, it has cost the Saturn program some time. We received only $71.5 million instead of the $127 million we asked for. But it would be too late now to do anything about it. We have lost some time there, there is no question about it.

As far as 1961 is concerned, however, the $230 million only seems to be lower than the $250 million we originally asked for because there are some other projects for which additional funds are provided in the budget, which will directly benefit the Saturn program. For example, in addition to the $230 million, there is $8 million for the Centaur project, which doubles as our top stake of Saturn. Also, there is $15 million for the 200,000-pound-thrust liquid hydrogen liquid oxygen engine, which will become our second stage engine. So the total amount flowing into the Saturn actually is approximately $250 million, as originally asked for, but we don't call it all

Saturn money. Some of it is carried under the heading of Centaur or of the 200,000-pound-thrust engine.

Mr. LEHRER. Could you tell us, if your recommendations last year for priority and funding for Saturn had been approved, would we be firing a Saturn before the time set under the current accelerated schedule?

Dr. VON BRAUN. Yes. I think the answer to your question is "yes." I mean had we received more money in 1960, half a year earlier, we would be half a year ahead on the program.

Mr. LEHRER. A half a year ahead of the current program?

Dr. VON BRAUN. Yes.

Mr. LEHRER. Thank you, Doctor.

Senator STENNIS. All right.

Senator Cannon?

SATURN ACCELERATION IS DESIGNED TO RECAPTURE GROUND IN SPACE RACE WITH RUSSIANS

Senator CANNON. Doctor, is the requested speedup in the Saturn program that you have represented here to help us regain or improve our position in this so-called race that many say we are not in?

Dr. VON BRAUN. Sir, I am sorry, I think I missed the gist of your question.

Senator CANNON. I say: Is the requested speedup in the Saturn program that you have represented to us here today designed to help us regain or improve our position in this so-called race that many say we are not in with the Russians?

Dr. VON BRAUN. Well, certainly.

Senator CANNON. That is the purpose of it?

Dr. VON BRAUN. Yes; that is the purpose.

Senator CANNON. Thank you.

Senator STENNIS. Thank you.

Dr. Silverstein, if you will come around here, please.

Dr. von Braun, we are certainly grateful to you for coming here, to hear your testimony, and to be with us for these hearings. We feel that you have been very helpful to us and to the country, too, in presenting this picture and in justifying the amounts of money that you are requesting. We are all interested in the fine progress that you are making. I don't know whether you are pressed for time now or not, but we would be very glad to have you stay.

If you have to go, of course, we understand.

Mr. HORNER. Mr. Chairman, Dr. Silverstein will be talking about the area of spacecraft development operation, generally. In accordance with our practice, I would like to suggest that pages 147 through 203 from the appropriations backup be entered in the record at this point.

Senator STENNIS. Without objection, it will be so ordered into the record at this point.

(The document referred to is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SOUNDING ROCKETS

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$3,556,170	$8,811,000	$8,000,000

1. OBJECTIVES:

To determine and understand the composition, structure, spatial distribution, dynamical behavior, and equilibria of the earth's atmosphere; to investigate the interactions of incident electromagnetic and particle radiations with the earth's atmosphere, including solar-terrestrial relationships; to determine and understand the relations between the earth's upper atmosphere and its surface meteorology; and to carry out exploratory geophysical and astrophysical investigations leading to later satellite and deep space probe experiments.

2. JUSTIFICATION:

A sounding rocket is a rocket used to carry a scientific payload to a height of up to one earth's radius, i.e. about 4,000 miles. The sounding rocket affords a means of investigating the earth's atmosphere in vertical cross section out to the distance at which the atmosphere merges with the medium of interplanetary space. Both exploratory and routine experimental programs are possible with relatively simple tracking ranges and launching sites. Many investigations of atmospheric structure, composition, ionization, motions, aurora, air glow, absorption of solar radiation, and interactions with cosmic rays and other particles can best be conducted by means of sounding rockets, particularly at altitudes below those at which satellites can remain in orbit. Moreover many sounding rockets are easily and quickly launched from shipboard or other special sites on short notice for the investigation of sporadic phenomena such as the aurora, magnetic storms, and solar flares. The

quickly launched from shipboard or other special sites on short notice for the investigation of sporadic phenomena such as the aurora, magnetic storms, and solar flares. The

sounding rocket also provides a means of testing under actual operating conditions equipment intended for later use in satellites or deep space probes, thus providing a check on the equipment before it is committed to the much more expensive vehicles. The current NASA program is based on experience gained from 13 years of rocket soundings, and is a program designed to extend and to fill in the gaps in the knowledge so far acquired on the earth's upper atmosphere and in rocket astronomy.

Operationally, the NASA rocket sounding program divides into 3 parts: (a) "low altitude" soundings up to 100 kilometers (60 miles), (b) "medium altitude" soundings reaching to 400 kilometers (250 miles), and (c) "high altitude" soundings above 400 kilometers, extending to one or several thousands of miles. Part (a) is directed toward completing our knowledge of the lower atmosphere, and includes detailed measurements and synoptic studies of geographical and temporal variations in atmospheric properties, with particular interest in relations of the higher atmosphere to surface meteorology. Part (b) involves the study of the high atmosphere, with particular emphasis on the ionosphere and solar-terrestrial relationships. This portion of the program also includes rocket astronomy. Part (c) involves the study of the outer portions of the earth's atmosphere and the fringe regions where the atmosphere merges into interplanetary space. Work in this portion of the program is still in its beginning stages, and measurements in the immediate future will be of an exploratory and survey nature, laying the groundwork for more detailed and precise observations later on.

3. PROGRAM PHASING:

In the fiscal year 1959 a large part of the work was devoted to the analysis of data obtained during the International Geophysical Year. In addition, work was started on the development and preparation of advanced instrumentation for continuing the rocket sounding program. Examples of this instrumentation include the development of a new type of magnetometer and the development of new types of mass spectrometers, pressure gages, and ionospheric instrumentation. During this fiscal year about 35 sounding rockets of the low and medium altitude types were procured for the sounding rocket program. Both low altitude and medium altitude soundings were conducted.

During the fiscal year 1960 the analysis of data obtained from sounding rocket flights in continuing. The medium altitude sounding program is being greatly strengthened and the rate of soundings increased. The development of advanced instrumentation begun in the fiscal year 1959 is continuing. About 75 sounding rockets are being procured and their payloads funded. Most of these are of the fiscal year 1960 altitude range, but some high altitude rockets are included. By the end of the fiscal year 1960 the rate of rocket soundings will attain a level of about 90 rockets per year. A beginning is being made in the performance of outer atmosphere experiments, using such vehicles as the Jason and Javelin rockets.

The funds requested for the fiscal year 1961 will permit the continuation of the rocket sounding program at the level of about 90 rockets per year, including purchase of the necessary rockets, preparation of the payloads, and analysis of the results. Development of advanced instrumentation will continue. In addition to continuing the low and medium altitude work vigorously with about 70 rockets, the high altitude soundings will be stepped up, with particular emphasis on the outermost portions of the ionosphere, interactions between the ionosphere and the radiation belt, studies of the aurorae, and studies of the earth's magnetic field.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Scientific and technical studies.....	$220,000	$711,000	$500,000
Development of advanced instrumentation.....	420,000	2,100,000	1,300,000
Flight research program:			
Sounding rockets.....	1,380,000	3,100,000	3,200,000
Payloads.....	1,536,170	2,900,000	3,000,000
TOTAL.....	$3,556,170	$8,811,000	$8,000,000

TOTAL.....	$3,556,170	$8,811,000	$8,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SCIENTIFIC SATELLITES

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$21,305,114	$23,813,000	$41,700,000

1. OBJECTIVES:

To determine the nature, extent, and dynamical behavior of the earth's outer atmosphere, and its relation to the medium of interplanetary space; to determine and understand the nature, extent, dynamical behavior, and causes of the earth's ionsphere; to understand the nature, extent, and temporal variations in the gravitational, magnetic, and electric fields in the vicinity of the earth; to understand the origin, nature, motions, spatial distributions, and temporal variations of particles reaching the vicinity of the earth and having energies appreciably greater than thermal; to investigate the electromagnetic radiations in all wavelengths, from gamma rays to radio waves, that reach the vicinity of the earth from the planets, sun, stars, galaxies, and interstellar and intergalactic matter, and to use these observations to extend our knowledge of these bodies; to determine and understand the interrelationships among the above listed phenomena; to determine and understand the environmental conditions encountered in the upper atmosphere and in interplanetary space, and the effects on vehicles traversing these regions, including effects on materials, equipment, and living organisms; and to determine and understand possible departures from the laws of classical physics which may be demonstrated under conditions of satellite flight.

2. JUSTIFICATION:

The projects under this program support the above objectives by providing for the continuation of a series of exploratory measurements followed by more advanced experiments. The exploratory measurements in new areas are intended to give order of magnitude estimates of the quantities under investigation and to probe for new discoveries. The advanced ex-

periments are designed to make accurate measurements within the ranges indicated by the earlier investigations. The knowledge to be gained will lead to a better understanding of the earth and man's environment and consequently to a better use of the environment to man's benefit. In this connection, it must be recalled that the surface meteorology of the earth, the propagation characteristics of radio waves, the auroras, the radiation belts, and other geophysical phenomena are closely related to the sun and the interactions of the sun and the earth. The proper investigation of these interrelations requires observations and measurements at the outermost portions of the earth's atmosphere, for which the artificial earth satellite provides an indispensable and highly effective tool.

3. PROGRAM PHASING:

In the fiscal year 1959 the analysis of results obtained from Explorer and Vanguard satellites was continued. A Vanguard satellite designed to furnish cloud cover information was placed in orbit. The development of advanced instrumentation for the measurement of cosmic rays, the application of accurate clocks to relativity experiments, radio beacons, electron density Langmuir probes, and for the measurement of solar ultraviolet radiation was initiated. Funding was initiated for the purchase of seven Juno II vehicles and one Thor-Able to be used in the launching of satellites. The construction and testing of payloads for these vehicles was initiated.

The analysis of earlier satellite results is continuing in the fiscal year 1960. Development of instrumentation is being undertaken for the measurement of atmospheric pressures, densities, temperatures, composition, and winds; and work is continuing on the Langmuir probe instruments and on the development of special satellite magnetometers. Funding is being largely completed during the fiscal year 1960 for the Juno II vehicles and the one Thor-Able vehicle for which procrement was started in 1959. The preparation of payloads for these vehicles for launching in the fiscal year 1960 and early in the fiscal year 1961 is continuing along with the proparation of the payloads for the scientific satellites to be launched by Delta vehicles the last half of the the fiscal year 1961 and the first half of the fiscal year 1962. The Thor-Able satellite Explorer VI, the Vanguard III satellite, and the Juno II satellite Explorer VII were launched and have already yielded valuable scientific results on the Van Allen radiation belt, the magnetic field of the earth, cosmic rays, micrometeorites, and solar-terrestrial phenomena, and, in addition, an elementary one-line television scanner was checked out.

tion belt, the magnetic field of the earth, cosmic rays, micrometeorites, and solar-terrestrial phenomena, and, in addition, an elementary one-line television scanner was checked out.

Fiscal year 1961 funds will be used to initiate the funding and procurement of two Atlas-Agena B and two Thor-Agena B vehicles and their payloads, and to procure seven Scout vehicles and four payloads. Three of the Scout vehicles are for the international program. The Thor-Able, Juno II, and Delta vehicles which have been used to this time are being replaced in the programming by the newer and more powerful Atlas-Agena B and Thor-Agena B vehicles. The Atlas-Agena B will be capable of launching satellites into very high altitude elliptical orbits and of launching heavier satellites into low altitude circular orbits. The Thor-Agena B will be used to launch lighter satellites into low and medium altitude orbits. The Scout is a versatile, solid propellant rocket capable of placing 200 pounds into a 300 mile orbit. The higher payload capacity of these vheicles makes it possible to install more scientific instrumentation in each payload for making more measurements simultaneously, thus increasing the value of each set of data.

The experiments planned for the fiscal year 1961 will provide information on atmospheric and ionospheric composition; atmospheric structure and dynamics; ionospheric structure and dynamics; the radiation belt and its associated magnetic field; the earth's magnetic field; and on meteoroid and other environmental factors affecting materials. An Atlas-Agena will be used to launch the orbiting astronomical observatory satellite into a circular orbit of about 500 miles altitude. This satellite will be stabilized in inertial coordinates and will be instrumented to perform astronomical observations not possible on the earth due to the interference presented by the earth's atmosphere. Another Atlas-Agena will be used to launch the orbiting geophysical observatory satellite into a highly elliptical polar orbit extending as far as 60,000 miles from the earth. This satellite will be instrumented with radiation counters, magnetic field instruments, and various detectors and equipment designed to obtain a description of the earth's atmosphere and environment from pole to pole and from a few hundred to 60,000 miles in space.

One Thor-Agena will be used to launch a solar geophysical satellite equipped with a pointing control and instruments for studying solar phenomena, and instruments for making terrestrial observations simultaneously. A Thor-Agena will also be used to launch the polar geophysical satellite into a low altitude circular polar orbit. This satellite will be instrumented for the determination and comparison of atmospheric and ionospheric structure, properties and composition, and for measurements of energetic particles and the magnetic field of the earth from equatorial to polar regions.

One Scout and its payload will be devoted to a detailed study of the radiation belt especially with respect to biological implications. Another Scout payload will be a satellite launched into a 300-mile polar orbit for studies of the interactions and interrelationships of the earth's atmosphere, magnetic field, and the energetic particles of cosmic rays, the radiation belt, and auroras. Other Scout payloads will probe the atmosphere and ionosphere to distances of 6,000 miles in studies of atmospheric composition and structure, and ionospheric charged particles distributions.

It should be pointed out in connection with program phasing that the purchase of vehicles and the initiation of preparation of payloads are both long leadtime items. Thus, vehicles purchased in one year are fired one or two years from the date of purchase. Similarly, the payloads for these vehicles must be started one or two years in advance of the actual launching.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Scientific and techincal studies	$1,155,114	$1,500,000	$2,000,000
Development of advanced instrumentation	1,520,000	3,061,000	6,000,000
Flight research program:			
Juno II vehicles	8,540,000	5,100,000	---
Thor-Able vehicle	2,120,000	727,000	---
Atlas-Agena B vehicles	---	---	3,000,000
Thor-Agena B vehicles	---	---	3,000,000
Scout vehicles	---	---	3,500,000
Satellite payloads	7,970,000	13,425,000	24,200,000
TOTAL	$21,305,114	$23,813,000	$41,700,000

	17,970,000	13,425,000	24,200,000
TOTAL.....	$21,305,114	$23,813,000	$41,700,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

LUNAR AND PLANETARY EXPLORATION

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$31,882,607	$49,000,000	$45,000,000

1. OBJECTIVES:

To acquire fundamental physical and chemical information on the moon and planets; to investigate space phenomena and their variations over the range of lunar and interplanetary distances; to explore the surface and nearby environment of the moon and to measure and describe in detail its characteristics, for example, the surface composition, radioactivity and structural features, and the magnetic and gravitational fields; to investigate the constituents, processes, and characteristics of the interplanetary regions so as to understand how and why they vary with time and location within the solar system; to extend these investigations to the detailed study and exploration of the planets; to develop improved means and techniques for the conduct of lunar, interplanetary and planetary investigations and explorations.

2. JUSTIFICATION:

As our nearest major body in the solar system, basically unchanged for billions of years, the moon itself offers unique potentialities for better understanding of historic and contemporary phenomena of the solar system and for clarification of basic physical, chemical, and biological concepts that are fundamental to modern science. It can be hoped that the moon will provide the first answers that will unlock the secrets of the origin and evolution of the solar system. Until now, progress along these lines has been subject to the limitations imposed by remote observations and indirect measurements. The understanding which can be gained from direct measurements and observations will be far greater. Space flight vehicles now offer research capabilities for overcoming many of these limitations.

In particular, it will be possible to utilize appropriate instrumentation to determine by direct measurement, lunar, planetary, and interplanetary characteristics, and thus provide a wealth of fundamental information on the nature, magnitude, distribution, and variations of the electromagnetic radiations, energetic particles, electric and magnetic fields, cosmic dust particles, lunar, planetary and solar atmospheres which are continuously interacting within the solar system. These interactions are already known to markedly influence the earth's atmosphere and fields, and a knowledge of their mechanisms will clarify our understanding of terrestrial phenomena.

The advancedment of scientific knowledge obtained from early lunar explorations and space probes and the experience that will be gained from the operation of space flight systems hundreds of thousands of miles from earth, will provide the basis for the appropriate design of instrumented spacecraft which will eventually explore the planets and deep space.

3. PROGRAM PHASING:

During the fiscal year 1959, lunar and cislunar space probes permitted evaluation of initial problems associated with the placing of yehicles into lunar trajectories and provided preliminary information on environmental characteristics of cislunar space. Work was initiated on advanced instrumentation and measurement techniques, including, for example, a lunar seismograph system, a plasma probe, a magnetometer to be used in lunar probe flights, and instruments for measuring lunar radioactivity. Pioneer IV, which was initiated by ARPA and transferred to NASA, was placed in permanent orbit around the sun. The instrumentation in Pioneer IV furnished valuable new data on the radiation belt and its extent into space, showing for one thing that the outermost portions of the radiation belt vary quite markedly with activity in the sun. Funding was initiated for an Atlas-Able vehicle to be used in placing a scientific payload in orbit about the moon, and a Thor-Able vehicle to launch a deep space probe. Development, construction, and testing of payloads for both lunar and deep space probe missions were initiated.

Work is being started during the fiscal year 1960 on the development of instrumentation and vehicle systems with improved capabilities for investigating cislunar space and beyond. The development of advanced instrumentation started in the fiscal 1959 is continuing. A lunar orbiter payload was designed and constructed for the Atlas-Able vehicle for which funding was started in the fiscal year 1959. A pre-flight failure of the vehicle made it necessary to pro-

biter payload was designed and constructed for the Atlas-Able vehicle for which funding was started in the fiscal year 1959. A pre-flight failure of the vehicle made it necessary to pro-

vide a second booster system. This launch attempt was unsuccessful. Additional lunar orbiters and probes are planned for launching in the fiscal year 1960 and in the fiscal year 1961. Work will also be started on planetary probe payloads. The Thor-Able vehicle funded in the fiscal year 1959 will be used to launch a deep space probe; its payload is being completed during the fiscal year 1960.

The funds requested under this program for the fiscal year 1961 will provide for the design and development of measurement techniques, scientific instruments, and spacecraft for use in lunar and planetary investigations. Work will continue on the construction and testing of advanced systems to observe, study, explore, and investigate the lunar environment, surface, and interior. Studies and preliminary research and development projects will be extended in the fiscal year 1961 to acquire needed technology for spacecraft with a capability for precise circumlunar orbits and instrumented soft landings. Terminal orientation devices and landing controls and propulsion units for spacecraft will be investigated. Design and construction of prototype instrumentation will be initiated for a lunar seismograph and gravimeter system, advanced penetrometers, thermistor probes, and fluorescence spectroscopes.

Beginning in the fiscal year 1961 the Atlas-Agena will be utilized for launching of lunar probe spacecraft. Construction and environmental testing will start on payloads for lunar impact missions with the objective of providing knowledge necessary for the proper design of soft lunar landing vehicles. These payloads will be instrumented to transmit data on the surface characteristics of the moon.

Typical projects included in the advanced development program for lunar, planetary, and interplanetary instrumentation will be: studies of infrared sensors and penetrometers for the investigation of lunar and planetary surface structures; improvement of plasma probes, geiger and scintillation counters for measurements the interplanetary medium; improvement of magnetometers to be used in particle flux-magnetic field correlations; beta and gamma ray detectors and spectral analyzers for studies of lunar surface radioactivity; and improvements of television type image transmission equipment for lunar studies.

An interplanetary space probe will be launched during the fiscal year 1961 by means of a Delta vehicle funded under the Delta development program. Design and development effort on the payloads for use in an initial pair of planetary probes will be carried forward with the expectation that Atlas-Agenas will be used as booster vehicles.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development.....	$8,102,607	$5,223,000	$9,000,000
Flight research program:			
Completion of Pioneer IV vehicle system operations.....	2,140,000	---	---
Thor-Able vehicle.....	2,843,000	---	---
Atlas-Able vehicles.....	4,097,000	3,446,000	---
Atlas-Agena vehicles.....	3,500,000	7,360,000	9,500,000
Design, development, fabrication, and launch of spacecraft and payloads.....	11,200,000	32,971,000	26,500,000
TOTAL.....	$31,882,607	$49,000,000	$45,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

METEOROLOGY

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$987,550	$7,930,000	$20,700,000

1. OBJECTIVES:

To establish a meteorological satellite capability for world-wide coverage and for providing observations of atmospheric elements required by the meteorologist in order to understand atmospheric processes and predict the weather. These elements include cloud cover, storm location, precipitation, temperature, wind direction, heat balance, water vapor and other constituents. To achieve this objective will require: (a) the development of stabilized satellites for polar orbits of 500- to 1,000-mile altitude and "stationary" satellites for equatorial orbits of 22,000-mile altitudes; (b) the development of suitable on-board detection equipment, including television, infrared detectors, radar and spectroscope; and (c) the development of adequate data storage, handling and communications equipment and techniques.

The long range objective is to develop the principles of a system of instrumented orbiting satellites and communications network by means of which world-wide meteorological information may be transmitted to the National Meteorological Center of the Weather Bureau for its operational use.

2. JUSTIFICATION:

The earth satellite represents a new observational tool which promises to be of great value to the science of meteorology and to the practice of weather forecasting. Although it would be a mistake to imply that such a device will eliminate our meteorological

limitations, there is no doubt that it will supply a tremendous amount of useful meteorological data not now obtainable. It will do this not only because of its ability to give world-wide coverage to some meteorological parameters, in contrast to the current five to ten percent coverage, but also because of its unique vantage point above the atmosphere which will make new measurements possible. Improved basic scientific understanding of atmospheric processess and a more comprehensive knowledge of world and regional climatology will result and these should assist in producing advances in weather forecasting and in approaches to weather modification and control.

The benefits to be derived from these improved capabilities in meteorology include convenience in planning personal activities, protection of life and property from weather disasters; safeguarding transportation; crop planning, control and protection; industrial planning of weather-dependent products, outdoor enterprises, and heating and cooling loads; eventual limited weather modification and control; and good will in return for providing current global meteorological data to other nations. In addition, the same meteorological data required for world-wide civilian needs can, by proper handling, be made to meet special military needs as well.

3. PROGRAM PHASING:

Project TIROS was initiated by ARPA and transferred to NASA in April, 1959. In addition to the support provided by ARPA in payload and booster development, NASA purchased the following items with fiscal year 1959 funds: (a) radiation detection equipment and associated ground equipment for a meteorological satellite (TIROS) to be launched once during the fiscal year 1960 and again during the fiscal year 1961; and (b) tracking, telemetering, data processing, and data analysis equipment and services for the satellites.

The fiscal year 1960 funds provide for the continuance of this program at an accelerated rate with strong emphasis on the development of equipment for a series of stabilized follow-on meteorological satellites. These include a radar feasibility study, the development of an electrostatic tape recorder, the development of a vidicon camera, optics and controls, radiation scanning heads, low resolution heat budget instrumentation, attitude control development, spectroscope development studies, the development of recorders, programmers, transmitter controls and receivers for the satellite. A substantial effort in basic meteorological research for the utilization of meteorological satellite data is also

programmers, transmitter controls and receivers for the satellite. A substantial effort in basic meteorological research for the utilization of meteorological satellite data is also being conducted. Studies using data from rocket probes, aircraft reconnaissance, and the current meteorological observation sources simulate the kind of information that will be available from satellites and develop techniques to be applied to the analysis of actual satellite data from TIROS. In the fiscal year 1960 TIROS I (containing TV to map cloud cover) will be launched.

The fiscal year 1961 funds have been programmed (a) to maintain basic research at approximately the same level; (b) to allow for some increased activity in the development of advanced instrumentation (specifically in the development of stabilized vehicle control systems, and in the further development of IR detectors, TV systems, radar, and spectroscope; (c) to launch TIROS II (containing both TV and IR sensing instruments); (d) to allow for increased activity in the analysis of data acquired from the meteorological satellites (TIROS I and II); and (e) to initiate payload development, booster vehicle purchase and launch of the follow-on meteorological satellite.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Atmosphere, radiation, and data systems research	$158,550	$1,250,000	$1,400,000
Development of advanced instrumentation	11,000	3,099,000	4,400,000
Flight research program:			
Payloads	818,000	3,581,000	9,200,000
Booster vehicles	---	---	5,700,000
TOTAL	$987,550	$7,930,000	$20,700,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

COMMUNICATIONS

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$3,574,806	$3,170,000	$5,600,000

1. OBJECTIVES:

To develop communications satellites and operating techniques for use in a world-wide communications system using satellites as relay stations for ground-to-ground, ground-to-satellite, and satellite-to-ground transmission of messages, data, voice and television; to develop communications systems for the transmission of scientific data from deep space probes to earth and of commands from earth to deep space probes; and to conduct studies of the application of active relay satellites to civilian and commercial communications.

2. JUSTIFICATION:

Long-range communications in the form of telephone, telegraph, and television networks are now accomplished by means of land lines, cables, long and short wave radio, and microwave relay stations. The total bandwidth of land lines, cables, and low-frequency radio is limited. Short-wave radio bands are crowded and are unreliable because of atmosphere interference and ionospheric irregularity. Ultra-short-wave or microwave radio is usually limited to line-of-sight range; long distance communication at these frequencies is commonly achieved by means of repeater stations.

Satellites offer the possibility of world-wide communications by ultra-short-wave or microwave radio because the line-of-sight range at satellite altitudes is very large. The bandwidth or channel capabilities at these wave lengths is sufficient for television and most other foreseeable communications needs.

bandwidth or channel capabilities at these wave lengths is sufficient for television and most other foreseeable communications needs.

The scientific exploration of outer space is accomplished by the use of deep space probes. The data these probes accumulate must be transmitted to earth, and the earth stations must be able to send commands to the probes at various points along their paths. This requires a two-way communications link between the earth and the probe.

3. PROGRAM PHASING:

During the fiscal year 1959, work was initiated on Project Echo - a project to place several 100-foot diameter inflatable spheres into circular orbits about the earth. These spheres will be used to reflect passively electromagnetic energy from one ground station to another. Part of the project is the development of the sphere itself, its packaging into a payload, and methods of inflating and ejecting the sphere from the final booster stage. A 12-foot diameter version of this sphere, which was also to furnish data for air density studies, was launched in August 1959 but failed to achieve orbital velocity. The development of a beacon to aid in the tracking of the satellites was started in the fiscal year 1959. Improvements were also made to the JPL Goldstone transmitter and receiving sites at the Jet Propulsion Laboratory.

In the fiscal year 1960, the large-sphere flight research program will be initiated. Several 100-foot diameter inflatable sphere payloads will be ejected from boosters in vertical sub-orbital shots to test ejection and inflation techniques. Following this, a 100-foot sphere will be launched to orbit. Communication experiments will be conducted between east and west coast transmitting and receiving stations, using the sphere as a passive relay.

Research and development will be conducted in the fiscal year 1960 in several areas. In the area of inflatable structures for use as passive reflector satellites, work will be done on radio propagation characteristics, the feasibility and development of larger structures, and on regidization techniques. Studies will be undertaken in the field of world communications needs, of communication satellite system requirements to fulfill these needs, and of the ground support systems required for their use. These studies will be directed toward providing recommendations for the optimum communications satellite system.

The fiscal year 1961 program is a continuation and broadening of the 1960 program. Additional 100-foot spheres will be launched for further communications experiments. Since a world-wide passive satellite communications system will require several satellites simultaneously in orbit, the development of a multi-sphere payload for launch by a single vehicle will be started.

One of these will be launched in 1962. Data transmission requirements will be studied, with emphasis on a data relay for meteorological satellites. The advanced equipment development program will result in prototype models of a high-gain antenna and mount. Development of suitable modulation systems will be initiated.

During the fiscal years 1960 and 1961, work on active relay satellites will be limited to studies on the civilian and commercial applications of these satellites, the requirements imposed by commercial needs on such satellites, and the application of pertinent developments resulting from the Department of Defense program.

During the fiscal year 1959, work in the area of deep space communications was carried out by the Jet Propulsion Laboratory as part of its Juno II program. Their work included the design of a space vehicle communications and tracking system for the Pioneer III and IV experiments and the evaluation and improvement of elements of existing systems.

In the fiscal year 1960 studies will be made to determine the requirements for deep space communications, and the development of new components will be continued. Fiscal year 1961 will continue studies and component development, and will provide for communications equipment for use in planned deep space experiments.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Communications satellite studies and equipment development	$284,806	$740,000	$1,100,000
Deep space communications studies and equipment development	---	400,000	350,000
Flight research program:			
Boosters	2,150,000	---	---
Payload development, procurement, and operation	1,140,000	2,030,000	4,150,000
TOTAL	$3,574,806	$3,170,000	$5,600,000

TOTAL.....	$3,574,806	$3,170,000	$5,600,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

MANNED SPACE FLIGHT

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$46,416,333	$87,162,000 1/	$107,750,000

1. OBJECTIVES:

To provide a capability for accomplishing advanced space flight missions with vehicles where on-board human intelligence and operations are required; to rationalize and refine the technology of manned space flight vehicles and associated systems; to achieve successful orbital flight and the recovery of a manned satellite with an ICBM booster and drag-reentry system; to evaluate the physiological and psychological effects of a space environment on man; to establish his capabilities and limitations for performing useful missions in space; and to devise and develop improved manned vehicles with increased capabilities for performing important advanced missions.

2. JUSTIFICATION:

The ultimate benefits that might accrue from manned space flight are, in a large measure, unknown. It is clear, however, that instrumentation alone will not tell us as much about the moon, or the planets, as man himself will be able to report once he has visited those distant places. Man contributes observational, analytical, and decision-making ability concerning both expected and unanticipated problems. He provides a vast flexibility of action for operation, correction, and maintenance of scientific and technological instrumentation and equipment that characterize his present usefulness in airplanes and in the scientific laboratory.

1/ Includes $12,200,000 requested in fiscal year 1960 supplemental estimates.

In order to provide the capability for the manned exploration of space, a progressive program of research and development has been undertaken. A broad range of investigations, directed to the solution of basic technological problems concerning vehicular configurations and construction, human factors, life-support equipment and accommodations, launching systems, stabilization and control, reentry and recovery systems and techniques, operational and scientific instrumentation, and other vehicular subsystems, is under way. These investigations are presently directed towards solution of the problems associated with the nation's first manned venture into orbit - Project Mercury. On the basis of extensive studies, it was determined that Project Mercury should be based on the use of an ICBM booster launching system and on a ballistic type of reentry into the atmosphere. The use of ballistic reentry offers the best potentiality for early success because of the relative simplicity and reliability of this approach. However, ballistic reentry pays for its simplicity with landing point dispersions that will be operationally and economically unacceptable for extended use. As Project Mercury nears completion, extensive studies and configuration tests in wind tunnels and free flight will be undertaken as part of a program to develop the capability for landing point control.

A crucial part of the system for attaining landing point control is the stabilization and control system. It is important that this system be capable of both manual and automatic operation, in order to enhance reliability through human back-up and in order to allow for the use of on-board human judgment to vary the landing site choice. A comprehensive study, including flight simulators for pilot training, will be required to provide this capability.

In order to meet the foremost objective of Project Mercury - the attainment of manned orbital flight at the earliest practicable date - additional funds in the amount of $12,200,000 have been requested as a fiscal year 1960 supplemental estimate. The additional $12,200,000 is required to pay for contractor overruns, changes in capsule design and construction, and for added capsule requirements. The design changes and added requirements have arisen as a result of development tests and a continuing analysis of safety requirements. The compressed time-phasing of Project Mercury between inception and scheduled flight has required that research, development, design, and fabrication be undertaken simultaneously. Under these conditions, experience has required that modifications to design, arrangement, and structure, be made during the conduct of the program. Efforts to make the Project Mercury system as safe as humanly possible have inevitably added to the cost, as detailed analyses have uncovered new schemes for enhancing the safety and reliability of the system.

be made during the conduct of the program. Efforts to make the Project Mercury system as safe as humanly possible have inevitably added to the cost, as detailed analyses have uncovered new schemes for enhancing the safety and reliability of the system.

3. PROGRAM PHASING:

During the fiscal year 1959, much of the pre-flight research and development effort for Project Mercury was accomplished and contracts were let for major components of the system. Specifications for the world-wide radio tracking network were prepared and sent out to prospective contractors.

During the fiscal year 1960, the major part of the Mercury pre-flight and flight development program will be completed, and component qualification and astronaut training flights will be initiated. The tracking network will near completion during this period.

During the fiscal year 1961, it is anticipated that the Mercury qualification programs will be essentially completed and that the tracking network will become operational. Large expenditures for the recovery operations and for the operation of the tracking network will be added to flight hardware purchases.

Systems for achieving landing point control will also be under study during the fiscal year 1961. In this connection, two major problem areas require immediate attention: the use of lift to reduce the landing area, and guidance and control methods for piloted landings. Extensive analyses will be made, and scale models of controllable reentry vehicles will be evaluated in wind tunnels. Flight simulators will be used to evaluate the pilot's capability to fly such vehicles.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Biological and human engineering studies	$170,000	$2,180,000	$2,090,000
Mercury development program	3,100,000	5,270,000	4,050,000
Advanced reentry configuration	---	---	800,000
Manual and automatic guidance and control systems for advanced reentry configuration	---	100,000	200,000

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Flight research program:			
Atlas and Redstone boosters	$20,840,000	$23,460,000	$25,650,000
Mercury capsules, support equipment, and support services	22,299,333	47,212,000 1/	35,290,000
Tracking network operations and equipment	7,000	5,410,000	24,670,000
Recovery operations	---	3,530,000	15,000,000
TOTAL	$46,416,333	$87,162,000 1/	$107,750,000

1/ Includes $12,200,000 requested in fiscal year 1960 supplemental estimates.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

VEHICLE SYSTEMS TECHNOLOGY

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$1,903,651	$6,737,000	$21,200,000

1. OBJECTIVES:

To conduct studies and to develop materials, components, subsystems, and systems which will provide the optimum structure, configuration, guidance, control, and orientation and auxiliary power systems for space investigations such as deep space missions, lunar missions, and earth satellite projects.

2. JUSTIFICATION:

Space exploration depends upon guidance, control, attitude, and stabilization equipment for placing vehicles into the desired trajectories and with the desired orientation. Much of the guidance and stabilization technology which has been developed for the ballistic missile is applicable to space exploration. For example, injection guidance for space missions may be directly appropriated from ballistic missile experience, with only the additional developments required to produce lighter weight systems and to adapt existing knowledge and guidance technology to larger boosters such as the Saturn. However, the total requirements generated by space missions are different in both kind and degree. Consequently, development effort is required to provide vehicle and component control at great distances from the earth. These developments relate to components and systems for sensing and modifying the velocity of spacecraft in a manner to follow prescribed trajectories. They also are needed for stabilizing spacecraft and components with respect to known coordinate systems such as those involved in establishing a proper propulsion thrust vector, controlling temperature through heat absorption or radiation, or in collecting solar energy. Further system developments are needed for sensing

position and orientation of spacecraft, subsystems or components, and for providing reaction forces to modify the orientation required in such applications as maintaining communication through the use of high-gain antennae.

Successful space missions also depend upon the protection of scientific instruments from the hostile environment of space. The pursuit of this objective leads to research on materials to provide protection through the fabrication of durable but light-weight structures or by the development of resistive materials from which components or instruments can be assembled.

In the area of vehicle engineering, emphasis is on structural aspects and integration aspects of the variety of subsystems which compose the spacecraft. As a part of this effort there is a study on types of propulsion systems which should be used under different conditions; studies on landing techniques; and a look at the general problems of entry and reentry.

3. PROGRAM PHASING:

Guidance and control activities during the fiscal year 1959 were restricted to research on components and to a study of NASA space mission requirements, with the objective of defining a productive guidance approach. During the fiscal year 1960, the first steps outlined in the guidance study are being undertaken: (1) the start of work on a first generation, or Phase I, inertial injection guidance system utilizing analog techniques and guiding all stages of the launch booster, (2) start on a Phase II inertial guidance system utilizing digital techniques and possessing great flexibility in programming, and (3) the development of a completely digital precision autopilot for use in earth satellite missions which require supervison through burnout of the final booster stage but which can be accomplished with less expensive control mechanisms. Radio guidance techniques were extended to the post injection, or mid-course, portion of space flight. Efforts at first generation vehicle-contained mid-course guidance, terminal guidance and attitude control will be undertaken during the fiscal year 1960 in the spacecraft developed as the connecting link between the capability of the Agena B booster and the desired circumlunar, or rough lunar landing missions.

In the fiscal year 1961 a start will be made on vehicle-contained capability for trajectory corrections. Terminal guidance and attitude control will be continued in conjunction with the development of more sophisticated spacecraft to be carried ton advanced boosters.

jectory corrections. Terminal guidance and attitude control will be continued in conjunction with the development of more sophisticated spacecraft to be carried ton advanced boosters.

Guidance and control equipment will be designed to provide the capability of circumnavigating a celestial body, establishing precise orbits, circularizing elliptical orbits at prescribed altitudes, controlling the approach and let down for soft landings, and providing a means for sample return from the moon and reentry into the earth's atmosphere either from escape velocity or from a satellite orbit. This will be accomplished through the evolutional development of vehicle-carried systems. Component development for controls and sensors must be carried on at a parallel rate.

Materials research will require increased emphasis during the fiscal year 1961 to provide knowledge relating to the behavior of materials under the three conditions of thermal equilibrium, namely, space flight, the cold lunar night, and the lunar day with its high level of infrared reflection; to thermal shocks resulting from transitions between these stages of equilibrium; and relating to the effects on materials during reentry from either escape velocity or satellite orbits.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Development of injection guidance systems	---	$3,804,000	$1,800,000
Development of mid-course guidance systems	---	50,000	1,300,000
Development of terminal guidance systems	---	---	250,000
Development of attitude control systems	---	---	200,000
Development of guidance and control system for Centaur-boosted spacecraft	---	---	13,000,000
Development of guidance and control system for Saturn-boosted spacecraft	---	250,000	1,650,000
Vehicle engineering	---	1,708,000	1,000,000
Advanced technical developments, components, and materials	$1,903,651	925,000	2,000,000
TOTAL	$1,903,651	$6,737,000	$21,200,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SOLID ROCKETS

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$615,898	$3,785,000	$2,800,000

1. OBJECTIVES:

To establish, on an experimental basis, the background which will allow exploitation for space vehicle use of the high reliability, simplicity, and economy of solid propellant engines; demonstrate advanced techniques in the use of very high performance solid rockets as upper stages and as auxiliary rockets for space vehicles; develop techniques for improving the utility and versatility of solid propellant rockets by devising improved and advanced methods for thrust vectoring, modulation, and termination; conduct studies and experimental programs to establish the application of solid propellant motors as first stage high thrust boosters for space vehicles; and to explore techniques for exploiting the properties of solid rockets for sounding vehicles to obtain greater simplicity and economy.

2. JUSTIFICATION:

Solid propellant rockets have several inherent advantages. From a logistic and handling standpoint, they are storable for extended periods of time, they utilize simple operating principles, they involve essentially no complex machinery, they are generally transportable in the loaded condition, and they offer advantages of simple firing techniques for relatively untrained launching crews. These general characteristics make for high reliability and, in general, lower costs in development and use compared to liquid rocket systems. The basic characteristics of solid rockets also allow them to be fabricated readily in different sizes on a short development time scale.

ability and, in general, lower costs. The basic characteristics of solid rockets also allow them to be fabricated readily in different sizes on a short development time scale.

From a performance standpoint, solid propellant rockets have two inherent characteristics which can be exploited to great advantage for propulsion in space booster vehicles. First, the physical properties of solid rockets allow them to be constructed to very high ratios of propellant to inert parts when employed as upper stages in a vacuum environment. The second advantageous performance characteristic is the ease with which thrust levels can be varied. It is not distinctly more difficult or expensive to develop thrust levels of 1,000,000 pounds as compared to the 100,000 to 500,000 pound thrust levels now employed.

The utility of solid rockets is limited by the present cumbersome and relatively inefficient techniques for controlling thrust level during burning, for terminating thrust, and for obtaining thrust directional control. In addition, the inability to reignite a solid motor after initial termination decreases its utility as a terminal stage or as a retro-rocket. While high propellant-mass ratios of .96 to .97 are achievable in solid rockets, little has been done to demonstrate on a significant size scale the achievement of such performance.

The proposed program will aim at improvement of the deficiencies discussed above and at the demonstration of some of the performance, reliability, and logistic advantages of solid rockets. A program will be continued to evaluate and develop new propellants for space propulsion as new ingredients and propellant materials become available.

3. PROGRAM PHASING:

The solid rocket program is divided into four parts as follows:

High performance motors: In the fiscal year 1959, work was initiated to demonstrate the feasibility of rocket motors with a propellant to loaded motor weight ratio of .96. In the fiscal year 1960, a limited number of static firings are being conducted to prove out these designs. In the fiscal year 1961, work will be continued on advanced techniques for achieving ratios of .96 and beyond, and for solving associated propellant geometry, case, and nozzle design and development problems. Advanced techniques for achieving economical sounding rockets of high performance will also be explored. Sufficient data should be available by the fiscal year 1961 to conduct design studies and initiate development of very high performance terminal stages for specific space vehicles.

Advanced thrust modulation and vectoring systems: Limited work was initiated during the fiscal year 1959 on exploring the feasibility of thrust modulation by ultra-sonics. The 1960 program is expanding the effort on thrust modulation and includes work on the exploration of new techniques for thrust vectoring and thrust termination. In the fiscal year 1961 work will be continued on the most promising programs. Studies to apply some of the advanced techniques to specific solid motors will also be initiated.

High performance propellant systems: In the fiscal year 1959 work was initiated on the evaluation of new propellants and ingredients, and on their incorporation into propellant systems for application to the unique needs of space propulsion systems. This effort will be continued in the fiscal years 1960 and 1961 with particular emphasis on exploiting the new ingredients and materials that are being synthesized and developed under programs sponsored by the Department of Defense.

Improved motor materials and manufacturing techniques: Solid rockets for space applications require manufacturing techniques of high reliability and precision. Fiscal years 1959 and 1960 programs were initiated on non-destructive inspection techniques, inspection criteria, and on advanced methods of fabricating rockets, such as building a loaded rocket motor in separate sections and then assembling them. These programs will be continued, and the non-destructive testing techniques and inspection criteria developed will be applied to motors actually being manufactured for application to space vehicles.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
High performance motors	$260,898	$1,515,000	$1,300,000
Advanced thrust modulation and vectoring systems	90,000	930,000	500,000
High performance propellant system	175,000	910,000	700,000
Improved motor materials and manufacturing techniques	90,000	430,000	300,000
TOTAL	$615,898	$3,785,000	$2,800,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

LIQUID ROCKETS

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$15,978,589	$30,328,000	$63,000,000

1. OBJECTIVES:

To develop an advanced capability for launching and propelling payloads for space exploration through the use of liquid propellant rocket engines; to improve the performance of space vehicles through the development of improved propellants and equipment; and to work out practical solutions for the technical problems occurring in development and operation of liquid propellant engines.

2. JUSTIFICATION:

The liquid propellant rocket is the mainstay for propulsion of the present and coming generation of space vehicles. To provide capability for launching and propelling payloads for space exploration requires the development of several new high-performance engines of different thrust levels. These include a large booster engine, engines using hydrogen-oxygen propellants in upper stages, and engines using propellants that are storable for prolonged periods of time in the space environment.

For missions aimed at launching large manned vehicles into orbit around the earth or for delivering large instrumented payloads on the surfaces of the planets, booster thrust levels significantly greater than those of ICBM engines are needed. Accordingly, a 1,500,000-pound thrust engine is now under development. Manned vehicular landings on the surface of the moon or planets with return to the earth can be accomplished by clustering 4 to 6 of these engines into a first-stage booster.

The full payload carrying capability of the booster engines can only be realized by the use of upper stages equipped with engines using high energy propellants. The use of hydrogen-oxygen as the propellant for upper stages of space vehicles will increase carrying capability about 50 percent per stage as compared to hydrocarbon-oxygen engines. One large engine using hydrogen-oxygen propellants is now under development. Experimental tests have demonstrated the feasibility of building an engine with a thrust level suitable for use with advanced vehicles on space missions.

3. PROGRAM PHASING:

A contract to develop a single-chamber engine of 1,500,000 pounds thrust was let in 1959. During the fiscal year 1959, thrust chamber hardware was fabricated and preliminary thrust chamber tests were begun. Other components of the engine were designed. Modification of existing test facilities to accommodate this engine and construction of one new test facility necessary for engine testing were undertaken by the Air Force. Fabrication of engine components and extensive testing of all elements of the engine will be started during the fiscal year 1960. Initial assembled engine tests with continued component development are scheduled for the fiscal year 1961.

During the fiscal year 1960, a development effort will be initiated on a large engine using high-energy propellants for application to advanced vehicles.

Applied research and experimentation as well as analytical investigations on advanced engine types will be carried out. Applied research on engine problems in the fiscal year 1959 was devoted to a determination of the feasibility of large thrust single chamber boosters. In the fiscal year 1960 applied research will include analytical and experimental investigations into causes and methods of avoiding combustion oscillations in large rocket engines, and applied research required in further development of the 6,000-pound thrust storable propellant rocket. In the fiscal year 1961 applied research funds will be used to continue the combustion oscillation investigations started in the fiscal year 1960, and to start a project to investigate liquid propellants capable of being stored in a space environment for prolonged time periods.

lation investigations started in the fiscal year 1960, and to start a project to investigate liquid propellants capable of being stored in a space environment for prolonged time periods.

The fiscal year 1961 advanced engine design investigations will include an investigation to determine methods of simulating operational characteristics of large engines through model tests; and the continuation of injector, thrust chamber, heat transfer, and chamber fabrication investigation pertinent to storable-propellant engines.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Advanced engine design investigations	$3,558,589	$3,688,000	$3,400,000
Applied research on engine problems	420,000	1,470,000	1,800,000
Development of 1,500,000-pound thrust booster rocket engine	10,000,000	24,200,000	41,000,000
Development of hydrogen-oxygen upper-stage engines	---	---	16,000,000
Development of storable propellant engines	2,000,000	970,000	800,000
TOTAL	$15,978,589	$30,328,000	$63,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

NUCLEAR SYSTEMS TECHNOLOGY

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$3,810,496	$6,000,000	$10,000,000

1. OBJECTIVES:

To develop the components and technology required to permit the development of nuclear powered systems to deliver large payloads to interplanetary objectives. The current emphasis in this program is on solution of the many technological problems that now stand in the way of nuclear system development.

2. JUSTIFICATION:

The two principal types of nuclear systems that are considered suitable for the propulsion of high payload rocket systems in space are the nuclear heat transfer rocket system and the electrical propulsion system using a nuclear reactor system to generate electrical power. The Nuclear Systems Technology program supports the work on the nuclear heat transfer rocket system and on the nuclear reactor electric power generating systems.

The nuclear heat transfer rocket is a system in which hydrogen is heated to high temperatures in a nuclear reactor to produce specific impulses in the range of 700 to 1,000 pounds of thrust per pound of hydrogen flowing per second. The high specific impulse potentially available from the nuclear heat transfer rocket permits the delivery of large payloads for various missions requiring high energy. The nuclear rocket can be used in booster rocket systems as well as in the space environment.

livery of large payloads for various missions requiring high energy. The nuclear rocket can be used in booster rocket systems as well as in the space environment.

Although early emphasis in the nuclear heat transfer rocket program was on research aimed at the development of large thrust or high reactor power first-stage rockets, the current goals of the program are aimed at accumulating the necessary research information required to develop a reactor flight test system that would be launched by chemical rockets. Such a system could eventually be incorporated into a space vehicle stage which would take off for its interplanetary objective after having been launched into an earth orbit by large chemical rockets. In this program, the NASA is working with the Atomic Energy Commission.

Nuclear reactor electrical power generating systems are required to supply the electrical power needed to accelerate charged particles or neutral plasmas to high velocities in order to produce thrust in the electrical propulsion systems which appear to have good capabilities for space missions. (The accelerator or thrust production components of the electrical propulsion systems are discussed under the program entitled Space Power Technology.) Analyses of space mission capabilities of these electrical propulsion systems have indicated that such systems will be competitive with the low thrust nuclear heat transfer rocket system described above. One of the disadvantages of the electrical propulsion system is the long trip time involved as the result of the low ratio of thrust-to-stage weight. One of the advantages of the electrical propulsion system is that the electrical generating equipment may be used for communications when the payload has been propelled to its planetary objective.

It is one of the purposes of the present program to do the research necessary to develop high power, light weight nuclear reactor electric generating systems. It is felt that the development of such high power systems must wait for the accumulation of various fundamental data and research on critical components of the system. In addition to the funds required for applied research leading to advanced high power systems, funds are included in this program to continue the development of a system for converting energy from nuclear heat to electrical power using currently available information. This conversion system will be matched with the SNAP-8 reactor being developed at the request of the NASA by the Atomic Energy Commission. This reactor electric system will produce enough power to supply communications needs for planetary missions as well as to test early versions of electrical propulsion systems.

3. PROGRAM PHASING:

The work under this program is divided into nuclear reactor electric generating systems and nuclear heat transfer rockets. The fiscal year 1959 funds for nuclear reactor electric generating systems were used to design conversion equipment for a nuclear-electric

system (SNAP-8) and to initiate fabrication of the components. In addition, work was started on the acquisition of data that will be required in the design of higher power, higher temperature systems. Funds for the support of the nuclear heat transfer rocket reactor test program were transferred to the Atomic Energy Commission to undertake the development of a pump that will be used in the test program. In addition, funds were used to initiate experiments (such as the effect of radiation on the properties of materials at cryogenic temperatures) that will supply information necessary in the eventual design and operation of nuclear rockets.

In the fiscal year 1960, the components of the nuclear electric system will be fabricated and component testing will be initiated. The work on the fundamental information required to permit the design of higher power, higher temperature systems will be expanded. For instance, work will be undertaken on the corrosion characteristics of high temperature working fluids. The support of the reactor test program will be expanded. The development of a pump for operation under the conditions required for early reactor testing will be completed, and research and development on a pump drive system will be undertaken. Work on the fundamental information that will be required in the design of nuclear rockets will be expanded. For example, work on shielding methods will be undertaken. The test loop for the study of radiation effects at cryogenic temperatures will be designed, fabrication will be started, and preliminary tests will be run.

In the fiscal year 1961 the first conversion system tests will be run as part of the nuclear-electric system (SNAP-8) development program. Much of the fundamental data required for the design of components of a high power, high temperature system should be completed so that early applied research design and experimental studies should be initiated on critical components of such systems. In the nuclear heat transfer rocket program, it is planned to develop the turbopump to full rated performance for use in higher power reactor tests than those considered in the fiscal year 1960 pump development. Work will be expanded on the other non-nuclear components that will be required in the nuclear rocket system.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Nuclear heat transfer rockets:			
Reactor test (Rover) support.....	$1,910,496	$3,000,000	$4,300,000
Applied research on nuclear rockets....	1,100,000	1,100,000	1,000,000
Bread board engine design.....	---	---	200,000
Total.....	3,010,496	4,100,000	5,500,000

Total.....	3,010,496	4,100,000	5,500,000

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Nuclear electric power generating systems:			
SNAP-8 development.....	600,000	1,000,000	2,000,000
Applied research on high power systems.	200,000	900,000	2,500,000
Total.....	800,000	1,900,000	4,500,000
TOTAL.....	$3,810,496	$6,000,000	$10,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SPACE POWER TECHNOLOGY

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
---	$4,814,000	$8,000,000

1. OBJECTIVES:

To develop electrical thrust devices and electrical power supplies based on energy sources other than nuclear reactors for application in space vehicles.

2. JUSTIFICATION:

Nearly all space vehicles require an electrical power supply (auxiliary power unit) to provide electricity for operating instruments, communications and other equipment. Solar cells and batteries are usually used, but for power requirements of 0.5 to 30 electrical kilowatts, other systems should be developed which will have a lower weight, higher reliability, or lower cost. Solar-heated systems using mechanical or static power conversion equipment appear promising for long duration missions in space. Chemical auxiliary power systems are desirable for certain missions. Improved storage batteries or regenerative fuel cells are desirable for energy storage in conjunction with solar auxiliary power unit systems. By placing reliance on the progress to be made in various programs sponsored by the Department of Defense, it is possible for NASA to limit its program on auxiliary power units in the fiscal years 1960 and 1961 to the development of a 3-kilowatt solar auxiliary power unit, with limited support of applied research and development on advanced solar and chemical systems.

Electrical propulsion systems are desirable because of their low propellant consumption for certain space missions. Applications include attitude control, orbit correction, main propulsion, and vernier control of velocity for spacecraft which have initially been boosted outside the earth's atmosphere. Research and development is needed on propulsion

tion for certain space missions. Applications include attitude control, orbit correction, main propulsion, and vernier control of velocity for spacecraft which have initially been boosted outside the earth's atmosphere. Research and development is needed on propulsion

by means of arc plasma jets, ion rockets, and plasma acceleration systems, for potential use with nuclear-electric and possibly solar-electric power supplies.

3. PROGRAM PHASING:

Funds for the fiscal year 1960 will be used to initiate the development of a 3-kilowatt solar auxiliary power unit, and to conduct applied research and component development on advanced solar and chemical power systems and on arc plasma jet and ion propulsion.

Funds for the fiscal year 1961 will provide for the continuation of applied research and component development projects and for initiating the development of plasma jet and ion propulsion systems. The scheduling of the development of electrical propulsion systems will be phased to match the availability of electrical power supplies, such as the SNAP-8 nuclear-electric power system.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Applied research and development.....	---	$1,914,000	$4,400,000
Solar auxiliary power unit development.....	---	1,600,000	2,100,000
Plasma jet rocket engine applied research and development.....	---	700,000	800,000
Ion rocket engine applied research and development.....	---	600,000	700,000
TOTAL.....	---	$4,814,000	$8,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SCOUT

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$6,048,000	$2,800,000	---

1. OBJECTIVES:

To develop a highly reliable, versatile, and inexpensive vehicle to extend capabilities for aerodynamic and space research.

2. JUSTIFICATION:

A review of the various scientific experiments to be performed over the next several years has indicated the need for highly versatile, reliable, and inexpensive vehicles which can be launched with minimum facilities and which can be used to conduct a wide range of scientific experiments. These experiments include placing a variety of scientific payloads into 300-500 mile orbits, high-altitude probes, high-velocity reentry tests, advanced heating and ablation studies, and many similar types of experiments. A study of the existing available vehicles indicates they are all complex and costly, and not fully optimized for the kind of mission and use described above.

The Scout vehicle is a natural extension and evolution of the multistaged solid propellant rocket systems that have been developed over the last ten years for high-velocity aerodynamic and reentry research studies. The solid propellant rocket systems have demonstrated a very high degree of reliability in operation. The systems also combine simplified logistics and handling inherent in solids so that a reliable and inexpensive vehicle can be achieved.

achieved.

The Scout vehicle consists of four solid rocket stages whose performance is representative of advanced state-of-the-art solid propellants. The guidance system incorporates three-axis stabilization with a digital pitch programmer and complete servo system. Aerodynamic controls consist of jet vanes and aerodynamic surfaces for the first stage, peroxide reaction jets for the second and third stages, and spin stabilization for the fourth stage. It will have capabilities for launching payloads of 150-200 pound in circular orbits at 300 miles; for placing 100-pound payloads at about 5,000 mile altitudes; for achieving very high-velocity reentry; and for use in space target identification and guidance system evaluation.

The use of solid propellant motors, the simplicity of components, and the simplicity of launching and handling techniques will allow launching of the vehicle from a variety of sites including the NASA's Wallops Station. A minimum of handling and launching costs are involved.

3. PROGRAM COSTS:

There are four major areas of development in the Scout program: the propulsion system, the guidance system, the airframe and the launcher. Contracts for the development and procurement of components in all four areas were initiated in the fiscal year 1959. The procurement includes eight sets of propulsion units, four guidance systems and air frames, and one launcher. The development and qualification of all the basic components for the Scout vehicle will be completed in the fiscal year 1960. Four additional guidance systems and airframes to complete the procurement for a total of eight vehicles will also be accomplished in the fiscal year 1960. Four vehicle flights will be conducted in the period January-July 1960. While the primary purpose of these flights will be vehicle evaluation, useful payloads will be incorporated on all flights except the first one. The balance of the eight vehicles will be fired during the fiscal year 1961 at approximately two month intervals and will incorporate specific payloads to carry out useful research programs. Additional data will be obtained on vehicle performance. Since it is anticipated that the development flight tests will be completed during the fiscal year 1961, no additional funds have been budgeted under this program for the fiscal year 1961.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Flight research program:			
Development and delivery of eight complete vehicles including launcher and ground test equipment.....	$6,048,000	$2,800,000	---
TOTAL.....	$6,048,000	$2,800,000	---

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

DELTA

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$12,927,417	$13,300,000	$12,500,000

1. OBJECTIVES:

To provide a reliable space flight vehicle for medium payload satellites and small payload space probes, replacing the present Thor-Able, Juno II, Jupiter C, and Vanguard vehicles.

2. JUSTIFICATION:

Space projects to date have utilized vehicles that have been adapted from military ballistic missile boosters. While providing valuable interim service, most of these vehicles suffer from technical limitations that restrict their desirability for long-term application as space vehicles.

The Delta space flight vehicle will replace the small-payload vehicles currently in use. It will be similar to the Thor-Able, but will have a coast-phase attitude control system, permitting higher injection altitudes. Delta will be a three-stage vehicle in which the first stage will consist of a production Thor missile with the nose cone and guidance unit removed. The second stage will consist essentially of the second stage used in Vanguard and Thor-Able with an improved radio-inertial guidance system of higher accuracy. The third stage will be a solid propellant rocket motor developed for Vanguard.

The Delta vehicle will be applied to a number of satellites and space probe projects. It will have a payload capacity of 300 to 500 pounds for satellite applications and up to 65 pounds for probe shots to the vicinity of the moon. Delta will be useful for both inclined and polar orbits and will be launched from both the Atlantic and the Pacific Missile Ranges. Requirements for greater lunar payload capability and for increased accuracy in achieving close tolerances for orbital circularity, and special demands for obtaining attitude stabilization of certain payloads, have all combined to dictate more stringent design limits on the vehicle. In the fiscal year 1961, funds will be expended to develop hardware intended to yield more precise and controllable flight paths and velocities while at the same time increasing payload weight capacity and attitude orientation.

3. PROGRAM PHASING:

The Delta program is divided into five parts: the fabrication and test of the modified Vanguard/Thor-Able second stage; the procurement and test of the guidance system; the modification of the Thor boosters; the integration of the complete Delta; and the preparation and launch.

Incremental funding for this program, including the procurement of twelve vehicles, was initiated during the fiscal year 1959. All phases of the vehicle engineering program have proceeded on schedule.

Funding for the fiscal year 1960 and beyond is required for the planned continuation of the initial contract. Specific sums proposed for obligation in a given fiscal year are not associated with particular vehicles. However, the fiscal year 1960 funding essentially supports hardware fabrication and flight operation costs for East Coast launchings; and the fiscal year 1961 funding will support similar operations from the West Coast and will also initiate the vehicle improvement program to increase reliability, accuracy, and performance.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Flight research program:			
Vehicle engineering and manufacturing, ground service equipment, and trajectory computations	$12,927,417	$11,645,000	$9,000,000

turing, ground service equipment, and trajectory computations	$12,927,417	$11,645,000	$9,000,000
Range and launching services, shipping costs	---	$1,655,000	$2,300,000
Vehicle reliability improvements and modifications	---	---	1,200,000
TOTAL	$12,927,417	$13,300,000	$12,500,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

VEGA

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$14,291,494	$4,000,000	---

1. OBJECTIVES:

The objective was to provide the first general purpose space vehicles in the National Space Vehicle Program. The Vega project was terminated on December 11, 1959, to reduce the number of rocket vehicles used in the United States space program. Other rocket vehicles in the national inventory will be used to accomplish the satellite and space probe projects for which the Vega had been planned.

2. JUSTIFICATION:

The Vega project included a two-stage and a three-stage vehicle system. In both, the first stage used the Convair Atlas and the second stage, a General Electric engine. The GE engine, originally used as the primary booster of the Vanguard, was being modified to include altitude start and re-start capability. The third stage used the 6,000 pound-thrust storable fuel engine currently under development by NASA's Jet Propulsion Laboratory. This particular engine will be continued as an advanced development for use in large spacecraft of the future. It is also expected that some of the material and components developed by Convair will be usable in the Centaur program.

3. PROGRAM PHASING:

During the fiscal year 1959, incrementally funded contracts were let for the design, development, fabrication and testing, and launching of eight Vega vehicles, including the requisite modification to the Atlas first-stage and the development of the Vega second-stage powerplant.

requisite modification to the Atlas first-stage and the development of the Vega second-stage powerplant.

During the fiscal year 1960 the preliminary design of the second stage, the construction of a captive test article and the development of the second-stage engine were continued. The construction of flight engines and vehicles was also initiated.

The Vega project was terminated on December 11, 1959.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960 (Including termination costs)	Fiscal Year 1961
Flight research program:			
Second stage development, fabrication, and testing	$11,290,000	$1,580,000	---
Third stage development, fabrication, and testing	3,001,494	2,420,000	---
TOTAL	$14,291,494	$4,000,000	---

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

CENTAUR

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$4,000,000	$37,000,000	$47,000,000

1. OBJECTIVES:

To develop a general purpose space flight vehicle employing a high-energy fuel in an upper stage.

2. JUSTIFICATION:

Centaur is a two-stage vehicle whose first stage is a modified Atlas "D" missile. The modification consists of replacing the cone frustum part of the forward liquid oxygen tank with a cylindrical section having the same diameter as the rest of the Atlas. Between the lower and upper stages is a structural adapter that is attached permanently to the lower stage. The upper stage is mounted on top of the adapter which is jettisoned with the modified Atlas booster. Sets of hydrogen peroxide rockets are utilized for upper-stage attitude control during the coast period. The significant feature of Centaur is the use of liquid hydrogen as a fuel, thus providing a launch vehicle of much greater capability than previously available.

The Centaur project was transferred from ARPA to NASA on July 1, 1959. Technical direction is by an Air Force team located at the Air Force Ballistic Missile Division and reporting directly to NASA Headquarters.

reporting directly to NASA Headquarters.

3. PROGRAM PHASING:

The Centaur missions will involve placing communications satellites in a stationary 24-hour orbit, and lunar and planetary probes. The first six developmental vehicles will be used for both vehicle systems tests and for payload missions.

During the fiscal year 1959 the Air Force let incrementally funded contracts for the development of the Centaur engines, for the development and fabrication of the Centaur second stages, and for the modification to the Atlas boosters.

The existing contracts will be continued under NASA funding during the fiscal year 1960 and 1961. During the fiscal year 1960 static tests of the complete Centaur powerplant will be run and preliminary design will be completed on the second stage. Tests will be initiated to simulate zero-g conditions on the liquid gas tank during coasting flight.

The final design of the Centaur powerplant and second stage will be completed and the flight test program will be started during the fiscal year 1961.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Flight research program:			
Procurement of booster vehicles....	$4,000,000	---	$6,500,000
Development and procurement of second-stage and engine.....	---	$37,000,000	39,500,000
Launching operations.....	---	---	1,000,000
TOTAL.....	$4,000,000	$37,000,000	$47,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SATURN

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
($19,325,020)[1/]	($55,182,980)[1/]	$134,308,000

1. OBJECTIVES:

To develop a multi-stage launching vehicle for various advanced space-flight missions.

2. JUSTIFICATION:

The Saturn program comprises a series of multi-stage launching vehicles of increasing payload capability for performing various space-flight missions. Minimum requirements for three important missions are: (1) to send large payloads to the moon and near planets; (2) to place several tons of payload in a 24-hour equatorial orbit; and (3) to place a manned spacecraft (such as Dynasoar) in an earth orbit. The first version of Saturn is designed to meet these requirements. Succeeding Saturn vehicles will have greatly increased capabilities for all three of the missions previously mentioned. The increased capability is to be obtained by using upper stages from the early versions as building blocks in the final vehicle, thus, minimizing the number of new stages that have to be developed. The Saturn's first stage is propelled by a cluster of eight ICBM-type engines which deliver a total thrust of one and one-half million pounds. The final version of Saturn will use up-rated engines giving a thrust of at least two million pounds. The first Saturn vehicle will be a three-stage rocket; the final version may have five stages. Launching of the first Saturn booster with dummy upper stages is scheduled for the latter half of 1961.

The Saturn project was initiated on August 15, 1958, by an order from the Advanced Research Project Agency to the Army Ordnance Missile Command. The project was funded in the

1/ Funded by the Department of Defense.

1/ Funded by the Department of Defense.

fiscal years 1959 and 1960 by ARPA. The President of the United Stated, on November 2, 1959, announced his intention to transfer the Saturn project to NASA. In anticipation of the transfer, NASA and the Department of Defense have established an interim working agreement that provides for immediate assumption by NASA of the responsibilities for the technical management of the Saturn vehicle development.

3. PROGRAM PHASING:

During the fiscal year 1959 the design of the first-stage booster and the design of tooling for the first-stage clustered tanks were initiated.

During the fiscal year 1960 the design and development of the first-stage booster was undertaken. Construction of prototype tankage proceeded, and individual engines were delivered for test. A captive firing of the eight engine cluster is scheduled for the latter half of fiscal year 1960. Contracts for upper stage engines and vehicles will have been let before the end of fiscal year 1960.

The fiscal year 1961 funds will provide for the continued development, construction, and testing of the first-stage booster tanks and engines. In addition, design and development of upper stages, initiated in the fiscal year 1960, will be continued. Part of the fiscal year 1961 funds will provide for the development of vehicle-borne guidance, controls and instrumentation, and the development of ground-service equipment.

4. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Flight research program:			
Development and fabrication of first-stage boosters	---	---	$57,500,000
Development and fabrication of upper stages	---	---	42,300,000
Guidance, controls, and instrumentation	---	---	12,800,000
Ground-service equipment	---	---	9,708,000
Direct material	---	---	12,000,000
Total	($19,325,020) 1/	($55,182,980) 1/	$134,308,000

1/ Funded by the Department of Defense.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

TRACKING AND DATA ACQUISITION

Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
$3,095,674	$16,266,000	$32,550,000

1. OBJECTIVES:

To operate tracking and data acquisition facilities necessary to support the overall NASA space flight program; to provide tracking and data acquisition support for space flight operations upon request by other government agencies; and to provide for research and development on improved tracking and data acquisition systems and equipment. Major technical objectives included in fiscal year 1961 program are:

(a) Improvement of the overall accuracy and efficiency of existing NASA tracking stations.

(b) Development of a prototype electronic tracking system of inherently greater precision than any present system.

(c) Development of communications techniques for spacecraft at planetary distances.

(d) Speed-up of data handling to reduce time lag between the experiment and the conclusions.

(e) Development of special trajectory measuring techniques and systems for complex payloads.

(c) Development of special trajectory measuring techniques and systems for complex payloads.

2. JUSTIFICATION:

In all cases of space flight operations, whether a scientific satellite, a space probe, a sounding rocket, or a manned vehicle, there is a need for tracking units capable of delivering orbital data or position time histories, and a need for telemeter receivers for data acquisition. These devices must be properly coordinated by communications links to permit the data to be transmitted to a suitable computing center, where it may be rapidly reduced to a form in which it can be studied and analyzed by the scientists. The data represents the raw material from which the scientific experimenters will gain their new knowledge of space. The quantity and quality of this raw material will determine the progress made in space research.

While the NASA network of stations is designed to afford the maximum amount of operational flexibility, there are special conditions associated with each test which may require equipment modifications, or in certain cases, the temporary installation of new items of equipment at new tracking locations.

In order to minimize the requirements for new stations, or to compensate for temporary deficiencies, the NASA proposes to provide support to cooperating non-NASA stations which are suitably equipped to perform a useful function for the purposes of a particular experiment.

ADVANCED TECHNICAL DEVELOPMENT

Tracking and data acquisition systems development: A continuing effort must be maintained to advance the state of the art in tracking systems and methods, in data reduction and analysis techniques, and in methods of telemetry and data transmission. Specific areas of basic research include theoretical studies and experimental verifications of the effects of propagation delays on various transmissions of time signals since accurate time measurement to within a fraction of a second is necessary in refined calculations of orbits; theoretical and applied research in low noise pre-amplifiers to improve reception of faint radio signals; theoretical studies and analysis of improved orbital computation methods; and studies into techniques for communicating with space vehicles at planetary distances.

In addition, development of refinements in the measuring capabilities of present minitrack systems is contemplated to meet more exacting requirements. Included are the development

of such items as a rubidium-vapor, frequency-standard equipment to improve calibration accuracy; precision propagation delay measurement equipment; on-site data reduction systems; and prototype calibration equipment to calibrate tracking systems.

The development of new types of tracking and data acquisition equipment is proposed which will have more accuracy than present systems. This work will include new antenna systems and receivers to operate at higher frequencies (2000 mc); transmitters for range determination; self-tracking systems for directional antennas; and payload beacons for use in conjunction with the ground systems.

Computer support programs: Studies will be undertaken to determine the best modulation technique for data acquisition and for the adaptability of the data received to computer programs for reducing the data. Consultative services will be used in this research effort.

Data systems development: Work will be continued in this area to foster the development of automatic data reduction techniques as well as to improve the data reduction on data now being received from telemetry systems operating in satellites in orbit.

Optical systems development: It is proposed to improve the present capability in this basic method of tracking especially for geodetic programs. Improvements are necessary in the timing system and in the methods of reducing data from photographic film accurately and rapidly. Electronic-optical techniques will be investigated to marry the advantages of electronics and optics into an improved system for tracking optically. Other work will include star cataloging, application of optical tracking to lunar or deep space vehicles, exploration of possible uses of optical telemetry, improvements in image converters and photo-detectors, and the use of light reflectors on payloads.

Mercury tracking net techniques: The Mercury tracking net will undergo continuing refinement and improvement to insure maximum effectiveness and reliability. Work will continue on data error analysis, telemetry systems, tracking techniques, and communications as applied to manned space flight. The use of contract consultants are relied on heavily in this work.

Development of high gain antennas: Many long range problems are involved in developing equipment to meet the requirements of communicating with vehicles at distances of millions of miles. While payload power is expected to increase, it will still be necessary to improve the antennas and receivers on the ground. In this connection it will be necessary to do considerable

antennas and receivers on the ground. In this connection it will be necessary to do considerable

research and development to design and develop techniques and systems to economically improve upon present large antenna systems to receive relatively faint signals.

Trajectory measurement and command equipment: Special types of equipment are needed for vehicles whose controlled trajectory go well beyond the range of established launching ranges. The type of equipment required will depend on the characteristics of the payload, and what command control functions are involved. Certain vehicles will have capability for stopping and starting powered flight in last engine stages. To control the operation of such stages at remote locations will require development of special trajectory measurement and command control equipment.

FLIGHT RESEARCH PROGRAM

Operation of satellite ("Minitrack") stations: During the fiscal year 1961 there will be fourteen Minitrack operating stations, including four new ones being installed during the fiscal year 1960. These stations employ radio interferometers and are used primarily for tracking satellites which send out radio signals, where precise real-time data is not required. They have all weather capability. They cannot track passive satellites (ones which do not emit signals) nor can they provide the precise orbit data available from optical systems. They have the advantage of being able to detect the angular direction of a satellite with respect to the station without prior information as to precisely where to look. These stations must be located in areas free of extraneous electrical disturbances. From a number of observations from different stations, a reasonable orbital determination can be made.

Each Minitrack station receives and records telemetry data on magnetic tape. Data from these stations are fed to a central control, communications, and computing center at the Goddard Center. Automatic data read-out equipment is being provided to speed up data collection and to permit tracking a greater number of satellites.

The operational cost of three Microlock stations is included in the 1961 estimates. These stations will be managed by the technical personnel that manage the Minitrack stations. The Microlock stations may eventually be integrated into the Minitrack net at common locations with the Minitrack stations.

Operation of optical tracking stations: The existing twelve Baker-Nunn optical stations will continue in operation during the fiscal years 1960 and 1961 under the technical and administrative direction of the Smithsonian Astrophysical Observatory.

The optical stations can photograph relatively faint space objects (satellites) against star backgrounds to provide a precise determination of the angular position of the object. Observations can only be made when the visibility is good and by virtue of sunlight reflected from the object. Therefore, observations can only be made in periods of clear twilight. Moreover, the camera can only see a small segment of the sky at a time, and it must have a prior knowledge of where to look or the satellite will pass out of range before the camera can search any appreciable segment of the sky. Information on where to look is usually obtained from Minitrack or similar electronic systems which do not have the acquisition limitations of optical systems.

It is theoretically possible from three or more optical observations to obtain the most precise orbital data of any technique known. For certain geophysical experiments, such as in geodetic and air drag experiments, the maximum precision of optical techniques is necessary. The optical stations must be located at sites where the weather conditions are such that good visibility generally prevails. This site limitation is not necessarily compatible with the site locations of electronic systems, which have other criteria governing their best location.

Included in the cost of operating the optical stations is the cost of data transmission, data reduction, and data interpretation which is performed by the Smithsonian Astrophysical Observatory at Cambridge, Massachusetts. Funds are included for the cost of the Moonwatch teams which are volunteer groups assisting the Smithsonian Astrophysical Observatory in securing observations of satellites at different places in the world, using simple telescope equipment. The compensation to the Moonwatch teams merely defrays expenses for materials and for certain items of equipment. There is no compensation for the volunteer services as such.

Operation of the deep space network: During the fiscal year 1961 it is expected that three stations will be operational. The JPL station at Goldstone, California is currently operational; the Woomera, Australia station will be added during the fiscal year 1960; and the South Africa station will be completed during the fiscal year 1961.

The deep space stations are used primarily for tracking and data acquisition from vehicles penetrating deep into space, such as lunar probes. They may also be adapted for gathering larger amounts of data, such as may be involved in the transmission of TV pictures from space vehicles. They are not suitable for satellites in low orbits because of the low tracking rates of the antennas. They have great sensitivity, however, to very faint signals which cannot be detected by ordinary electronic systems. They also are being equipped to be capable of trans-

detected by ordinary electronic systems. They also are being equipped to be capable of trans-

mitting signals to space vehicles at great distances for the purpose of issuing commands to the vehicle. The transmitters will also be able to be used for communications satellite experiments.

Funds are included under this heading for the contractual services required in the operation of auxiliary portable trajectory tracking and command station equipment in the fiscal year 1961 to meet operational requirements involved in trajectory measurement and guidance functions on deep space probes.

Operation of Mercury net stations: A total of about 18 stations are included in the Mercury network of stations, including the control center and the communications and computing center. The operation of these stations and the recovery operations will be a joint effort involving the Department of Defense, foreign countries, and NASA. The communications system will primarily utilize leased commercial lines and military circuits.

Operation of non-NASA stations: The NASA will make use on a part-time basis of a number of cooperating non-NASA stations which provide tracking capability. Examples are the facilities at Jodrell Bank, England, and at Fort Churchill, Canada. The extent of the NASA use of these facilities is arrived at by mutual agreements based on the duration and complexity of the particular experiments. In certain cases the NASA may provide funds for special items of equipment needed to accomplish particular experiments.

Operations at AMR and PMR stations: All NASA sounding rockets, satellites, or space probes will be launched during the fiscal years 1960 and 1961 from either the NASA Wallops Station, the Canadian station at Fort Churchill, or the Department of Defense AMR or PMR stations. The majority of the launchings will take place at the AMR station. Reimbursable items of cost for use of the AMR and PMR stations will include utilities for NASA offices and operations and special items of equipment related specifically to NASA experiments in specific missions.

Other operational costs: A portion of the funds requested under this program will be used to procure services involved in the transmission of the data acquired at Wallops to the appropriate communications center and for data reduction services under contract. As the computer capabilities of the Goddard Center increase, the contract costs for data reduction services will decrease.

The NASA will have over 40 tracking stations in operation, including the Mercury stations, in the fiscal year 1961. An estimate of approximately ten percent of the overall operating costs of the stations has been added to provide adequate funds for maintenance and repair, provisioning of spares and logistic materials such as tapes, and various paper materials.

3. PROGRAM COSTS:

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Advanced technical development:			
Tracking and data acquisition systems development	---	$850,000	$2,670,000
Computer support programs	---	160,000	200,000
Data systems development	---	330,000	900,000
Optical systems development	---	50,000	900,000
Mercury tracking net techniques	$507,674	500,000	500,000
Development of high gain antennas	348,000	175,000	1,000,000
Trajectory measurement and command equipment	---	1,275,000	1,050,000
Total	855,674	3,340,000	7,220,000
Flight research program:			
Operation of satellite stations:			
Operation of Minitrack and Microlock stations	1,250,000	3,000,000	4,750,000
Data transmission	200,000	500,000	850,000
Total	1,450,000	3,500,000	5,600,000
Operation of optical tracking stations:			
Operation of Baker-Nunn stations	410,000	1,450,000	1,950,000
Moonwatch teams	50,000	250,000	250,000
Data transmission and reduction	150,000	800,000	1,300,000
Total	610,000	2,500,000	3,500,000

Total.....	610,000	2,500,000	3,500,000

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Operation of deep space stations:			
Operation of Goldstone station.....	---	$1,400,000	$1,250,000
Operation of Woomera station.....	---	---	850,000
Operation of South Africa station.....	---	---	600,000
Trajectory equipment operation.....	---	---	400,000
Data transmission.....	---	---	400,000
Total.....	---	1,400,000	3,500,000
Operation of Mercury net stations:			
Operation of Mercury stations.....	---	1/	1/
Data transmission.....	---	1,000,000	5,450,000
Total.....	---	1,000,000	5,450,000
Operation of non-NASA stations:			
Jodrell Bank, England.....	$180,000	200,000	300,000
Fort Churchill, Canada.....	---	650,000	700,000
All other.....	---	50,000	400,000
Total.....	180,000	900,000	1,400,000
Operations at AMR and PMR stations:			
AMR operations.....	---	426,000	1,500,000
PMR operations.....	---	200,000	600,000
Total.....	---	626,000	2,100,000
Other operational costs:			
Wallops Station data transmission.....	---	200,000	350,000
Data reduction services.....	---	2,250,000	800,000

1/ Funding included under "Manned space flight" program.

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Network Maintenance and repairs.....	---	$250,000	$1,800,000
Network spares and materials.....	---	300,000	830,000
Total.....	---	3,000,000	3,780,000
TOTAL.....	$3,095,674	$16,266,000	$32,550,000

TESTIMONY OF DR. ABE SILVERSTEIN, DIRECTOR OF SPACE FLIGHT PROGRAMS, NASA

Senator STENNIS. Dr. Silverstein, you are Director of the Office of Space Flight Programs—is that your title and field of responsibility?

Dr. SILVERSTEIN. Yes, sir. The first part of that shown on the board here is Space Flight Programs, the Office that I direct.

Senator STENNIS. All right. We are glad to have you here, Doctor. You proceed in your own way.

I don't know whether you have a prepared statement or not.

Dr. SILVERSTEIN. I have no prepared statement. I will testify from the charts.

Senator STENNIS. All right; you may proceed in your own way in describing the justification for your program.

Dr. SILVERSTEIN. Dr. von Braun just mentioned that in NASA we have a broad program covering what we feel are the essential elements for the exploration of space.

NASA PROGRAM HAS THREE PRINCIPAL INGREDIENTS

Now, this program has in the main three principal ingredients. One of them is the scientific exploration of space, using sounding rockets, satellites, probes out around the moon, into interplanetary space, and to the planets. We have a program that is aimed toward utilizing space in a practical way for the benefit of man and a program aimed at manned space flight currently conducted under our Mercury program. These are the three main divisions of the program.

In the testimony yesterday, I think you were briefed on the long-range plans of NASA, and also on the booster developments that General Ostrander and Dr. von Braun have discussed this morning.

I would like to go ahead by giving you a shorter range and more detailed picture of our flight program, and have that supported by Dr. Pickering and Mr. Goett, who will testify later. These are the gentlemen who are the directors of our operating laboratories, Dr. Pickering at the Jet Propulsion Laboratory and Mr. Goett at the Goddard Space Flight Center.

SOUNDING ROCKET PROGRAM

Now, to show the program, I have prepared some charts, which will be on this rear chart stand. The first of these deals with the program we have on sounding rockets (chart 43, Sounding Rockets).

CHART 43

SOUNDING ROCKETS

	FY 1960		FY 1961			
QUARTERS	3	4	1	2	3	4
ATMOSPHERE	3	4	4	4	3	3
SYNOPTIC ATMOSPHERE	2	2	9	9	6	6
IONOSPHERE	2	2	2	2	2	2
ENERGETIC PARTICLES	2	6	2	1	3	2
MAGNETIC FIELD	–	5	1	–	2	3
ASTRONOMY	6	8	8	8	6	6
SPECIAL	10	3	3	1	2	2
TOTAL	25	30	29	25	24	24

05-1-27 609

I may explain that the sounding rocket is a rocket that is fired from the earth up to an altitude of perhaps one earth radius, 4,000 miles. It may go anywhere between the earth and 4,000 miles. They are generally smaller vehicles than we are using in our space program, much less expensive, and are used most particularly for the exploration of the space in a vertical cut through the outer atmosphere. They are also used as testing vehicles for our instrumentation developments. As you know, and you will see later, the instruments we use for space flight exploration are very complicated. They require new technical and scientific developments, and it is very important that we take steps to very carefully develop these instruments before we fly them on satellites because the satellite missions are so expensive.

We have established a program for 1960 and 1961 fiscal years, which is shown on the first chart. It deals with scientific explorations of the atmosphere, ionosphere, energetic particles, astronomy, and other test objectives. This program will involve some 100 sounding rocket flights during that period covered by our 1961 budget. Now, after we develop the instruments in the sounding rockets, we are in a position to fly them aboard our satellites and our probes.

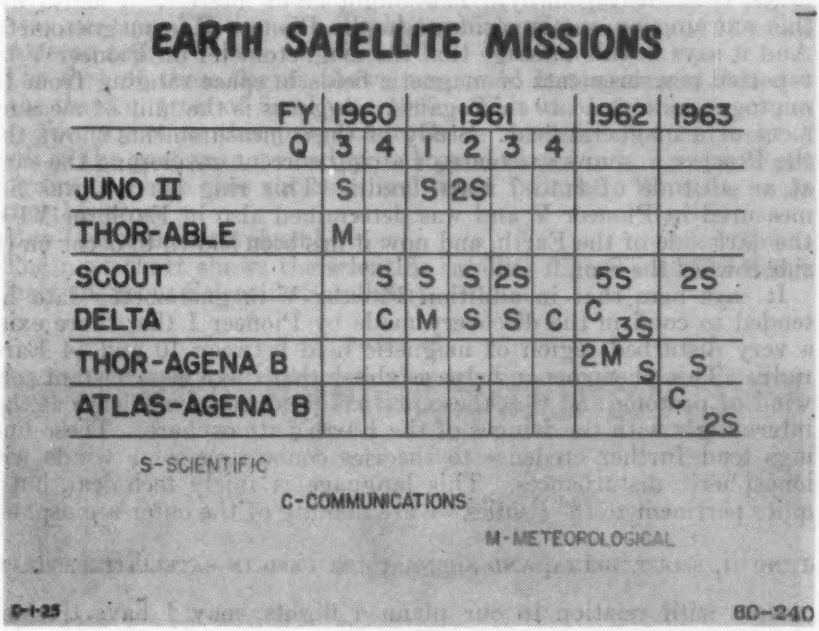
We continue our program, and—may I have the next chart?

PLANNED EARTH SATELLITE FLIGHTS

That shows an outline for the next several years of our planned earth satellite flights (Chart 44, Earth Satellite Missions).

We will conduct these flights with a number of different vehicles, which are listed on the left of the chart, including the Juno-II vehicle, the Thor-Able, the Scout, the Delta, the Thor-Agena B, and the Atlas-Agena B.

CHART 44



Now, on this chart we show three types of flights—in three colors. The blue are the scientific flights, the green are communications flights, and the "M" are meteorological flights. We show them through different time periods, with the different vehicles.

Now you can see that this is a fairly heavy firing program. The scientific flights are scattered through the period. We have meteorological flights occurring in the third quarter of 1960. The quarters are shown on the second line—third and fourth quarters, and then the first, second, third and fourth quarter of 1961. These flights in general provide us an integrated approach to the scientific application of space. What we are doing, basically, is sending up instruments to measure the magnetic fields in space, the parallels coming in from the Sun, the interaction of radiations from outer space on the magnetic field. We are attempting to understand the environment of outer space, so that when we are ready, and when our technology is developed, as has been explained in part by Dr. von Braun, we will be able to fly men to the vicinity of the Moon, circumnavigate the Moon, and at some later time perhaps land on the Moon.

There are problems. We must know before we send a man into space how he will react to the radiation environment of space. We must know before we design the spacecraft in which the man is to live how much we must provide in the way of radiation shielding, because this greatly adds to the weight and determines the type of vehicle we need.

NEW MAGNETIC FIELD DATA FROM PIONEER V

These programs are moving along quite well. As you know, recently we fired the Pioneer V vehicle from which we are currently

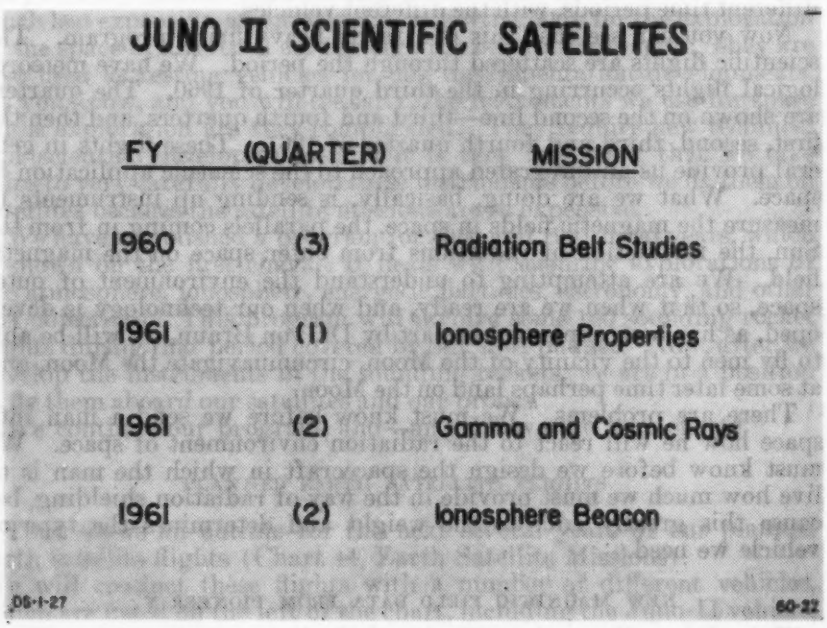
getting excellent information. Currently it is out about 2½ million miles, broadcasting daily. This might be of interest. I had a wire this morning on one experiment in the Pioneer V, a magnetometer. And it says in this message that the magnetometer on Pioneer V has reported measurements of magnetic fields in space ranging from 100 microgauss down to 10 microgauss. A gauss is the unit of measurement of a magnetic field. Study of these measurements shows that the Pioneer V shows existence of a ring current enveloping the earth at an altitude of 5 to 7 Earth radii. This ring current was first measured in Pioneer V and was determined also in Explorer VI on the dark side of the Earth, and now it has been shown to occur on the side toward the Sun.

It says here that in addition Pioneer V magnetometer data has tended to confirm the discovery made by Pioneer I that there exists a very disturbed region of magnetic field between 10 and 14 Earth radii. This phenomenon helps establish that there is a constant solar wind of protons, and that these protons produce a turbulence as they intermingle with the fringes of the Earth's atmosphere. These findings lend further credence to theories connecting solar winds with ionospheric disturbances. This language is fairly technical, but is quite pertinent to the studies we are making of the outer atmosphere.

JUNO II, SCOUT, DELTA, AND AGENA TO BE USED IN SATELLITE PROGRAMS

Now with relation to our planned flights, may I have the next chart, which shows the types of studies we are going to make, first in the Juno II vehicles (Chart 45, Juno II Scientific Satellites).

CHART 45



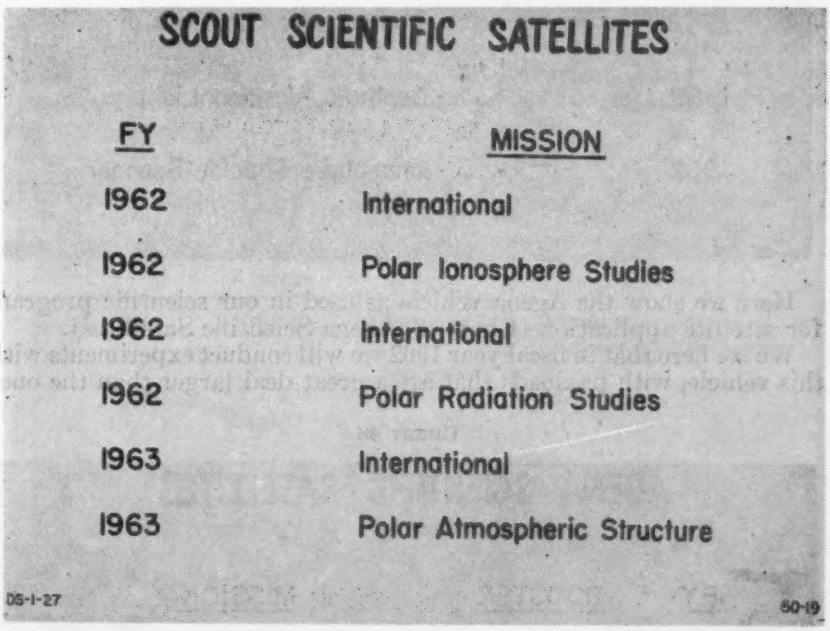
Here we show some five flights with the Juno II vehicle, which, as was mentioned to you, is a Jupiter vehicle with a series of 15 small rockets on top.

The first of these flights shown was tried last week and failed—in the third quarter of fiscal year 1960. This was a failure in a Juno II. We expect in this program to have successes and failures. I think in the past year we had quite a good record in our major flight program on some nine successes and seven failures. We hope to do better this year.

May I go to the next chart?

The next chart shows the scientific satellite flights with the Scout (Chart 46, Scout Scientific Satellites).

CHART 46



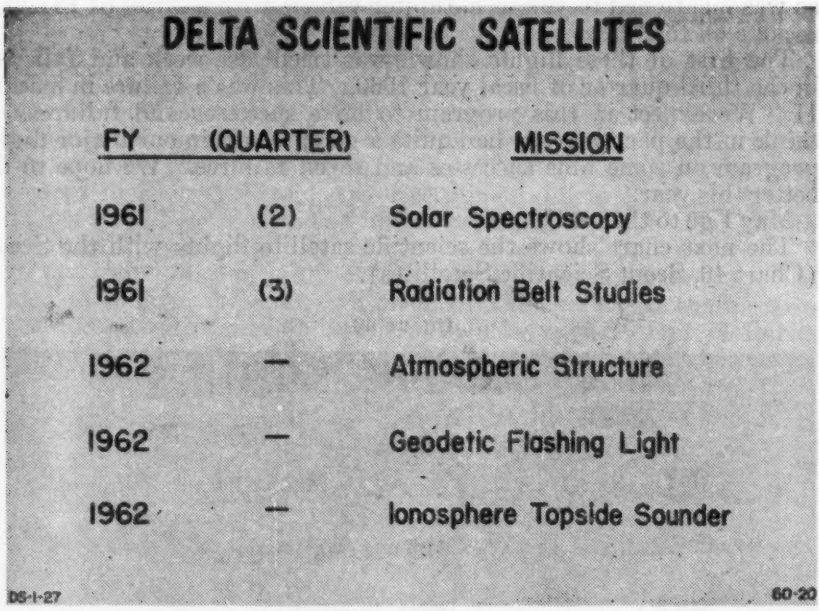
The Scout, as you know, is a solid rocket vehicle, coming along in development, which we expect to use in our scientific program. And this is the list of firings for the various purposes. As you will see, there are three Scouts that have been assigned to the international program, which is a program that NASA has entered into with foreign countries. These, in particular, are related to our program with Great Britain.

May I have the next chart?

Here we show the use of the Delta vehicle in our scientific program (Chart 47, Delta Scientific Satellites).

This involves measurements of solar spectroscopy, more radiation belt studies, atmospheric structure, the geodetic satellite, and an ionospheric topside sounder. This program will go ahead. The Delta vehicle is coming along very nicely in our program, and we expect to use it in these time periods.

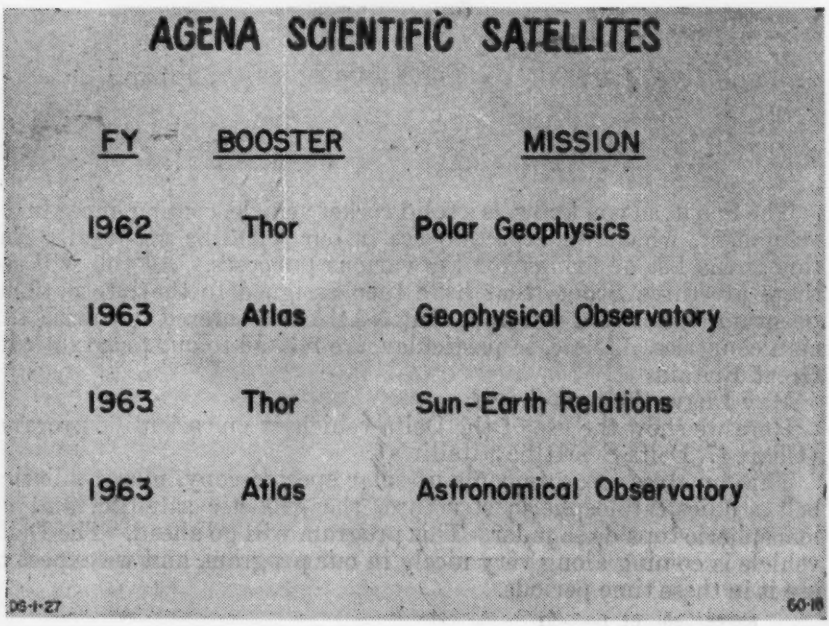
CHART 47



Here we show the Agena vehicle as used in our scientific program for satellite application (Chart 48, Agena Scientific Satellites).

We see here that in fiscal year 1962 we will conduct experiments with this vehicle, with payloads that are a great deal larger than the ones

CHART 48



we are using now. It is possible with the Agena to put satellite payloads in the order of 4,000 to 5,000 pounds into orbits of 300 to 500 miles above the Earth. These payloads shown on this chart will vary from the some 1,200 pounds carried with the Thor-Agena up to 4,000 or 5,000 pounds carried on the Atlas-Agena.

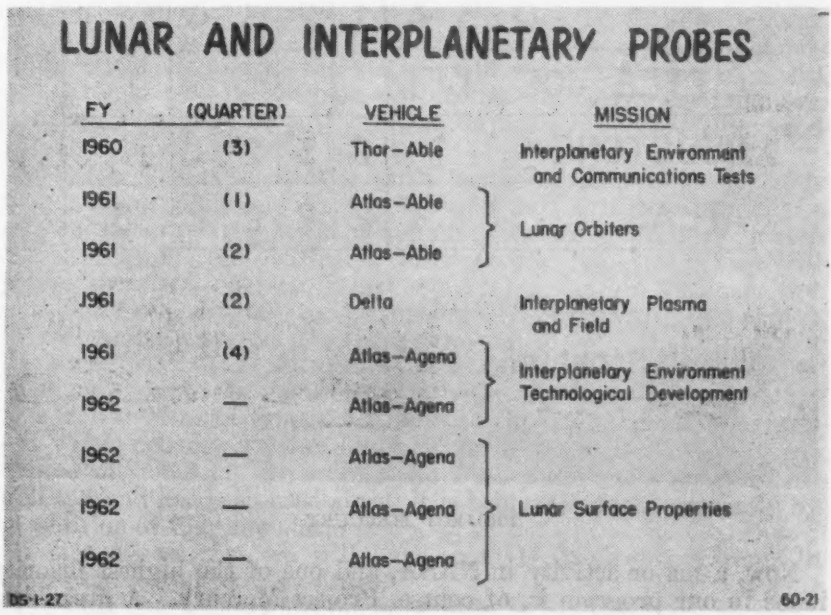
These experiments are very important to our program since, because of the added payload capability, they lay the groundwork for the really extensive measurements in space that we are hoping to make. This in a sense marks the beginning of what we might say will be our really advanced program.

The program before this time has been utilizing vehicles that we have built up for the program out of existing parts.

LUNAR AND INTERPLANETARY PROBES

Now, in addition to this satellite program that I have been discussing, we have a program of exploration in the neighborhood of the moon, and farther out into space. On this chart, I show flights that we are going to make (Chart 49, Lunar and Interplanetary Probes).

CHART 49



Again, the first of these—one marked for the third quarter of 1960, is the Pioneer V flight which we have already accomplished. We expect to fly during fiscal year 1961 an Atlas-Able vehicle with the lunar payload that thus far we have unsuccessfully flown. As you recall, around Thanksgiving we attempted a flight with this payload. It was unsuccessful. We had a failure of the fairing over the payload which came off, and at about the speed of sound, as the rocket was going through the atmosphere. This failure of the fairing resulted in the loss of the payload.

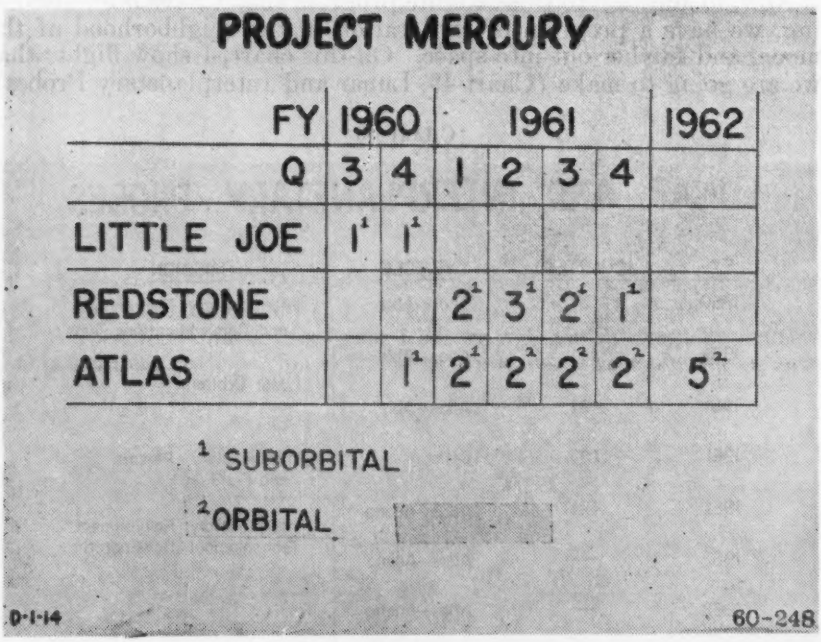
We intend to repeat this experiment. In the interim between that flight and the time that we show here, we have gone back into the laboratory, have restudied the payload. We have restudied mounting the payload on the vehicle, and of course provided that this fairing should not come off again.

There are additional flights planned in the lunar and interplanetary program.

Coming down to the program of the Atlas-Agena I think Dr. Pickering will discuss in more detail a little later. This chart does not show flights with the Centaur, which are proposed now for the Venus and Mars missions to occur sometime in fiscal year 1963, but these are currently being developed within our program.

Next chart, please (Chart 50, Project Mercury).

CHART 50



PROJECT MERCURY

Now, a major activity in NASA, and one of the highest priority items in our program is, of course, Project Mercury. A great deal has been said, I think, in our past hearings about the nature of this project, which involves the firing of a capsule into an orbit around the Earth by means of an Atlas vehicle. This schedule shows the elements of the program, part of which are suborbital, and part orbital.

Our feeling in this program has been that it is necessary that each item that is involved in this flight be qualified thoroughly before the final flight which involves the man. We have set up these flights shown here, and these time periods, to accomplish this qualification

of the equipment and of the man. The program is making good progress.

I had the opportunity just yesterday of visiting the site where the capsule is built. We see these capsules on the line. We feel that there is a good chance that we can move ahead in the program, as is indicated. We do expect to encounter difficulties in this most advanced of our technical areas. We will hope, as we encounter them, to solve them, and move ahead rapidly.

Now, one of the important ingredients in the Mercury program, as it is in all of our programs, is the acquisition of data from the satellites and probes. In Mercury it is particularly important that we keep continuous contact with the astronaut aboard the capsule, and more than that, we must know every second in real time where the capsule is.

We have established a very extensive net of stations which have the job of tracking the Mercury satellite, and also of acquiring the data which is being transmitted by telemetry from the capsule to the ground. This map shows the locations of stations for the Mercury capsule (Chart 51, Mercury Network).

There are some 19 stations, including a control center at Cape Canaveral. These are distributed around the world, along the flight path for the Mercury capsule. At these stations there will be in many cases tracking radar systems, telemetry reception equipment, communications stations, and we will station at these points doctors who will be able to evaluate the telemetered information that is coming down regarding the condition of the man's respiration, his heartbeat, and so forth.

Now, the Mercury network, again, has been contracted for. It is moving along rapidly. We are entering into agreements with the many nations involved in this program. We are utilizing their help in the program. In Australia, for example, the Australians will operate these stations. In other areas, where agreements have not been finally reached, we are moving rapidly along with negotiations.

We also have networks for other purposes.

Next chart (Chart 52, Minitrack Network).

You may recall from some of our previous testimony that we operate the so-called Minitrack network for observations of unmanned satellites. This network was initially established during the IGY for the purpose of obtaining data from the IGY satellites, the Vanguard satellites, and has been used since; it is being developed currently by the addition of four new stations.

It means now that we will have some 14 Minitrack stations to acquire data from our satellites.

The next chart shows a companion piece to the Minitrack network, which is the so-called SAO Baker–Nunn camera stations (Chart 53, SAO Baker–Nunn Cameras); the SAO refers to the Smithsonian Astronomical Observatory, which operates these stations for us under contract.

They are distributed around the world and consist of cameras that can take pictures of these satellites and can accurately fix the position of the satellite orbits.

These stations have been in operation for several years and we continue to support their operation.

Next chart (Chart 54, High Gain Antenna Stations).

CHART 51

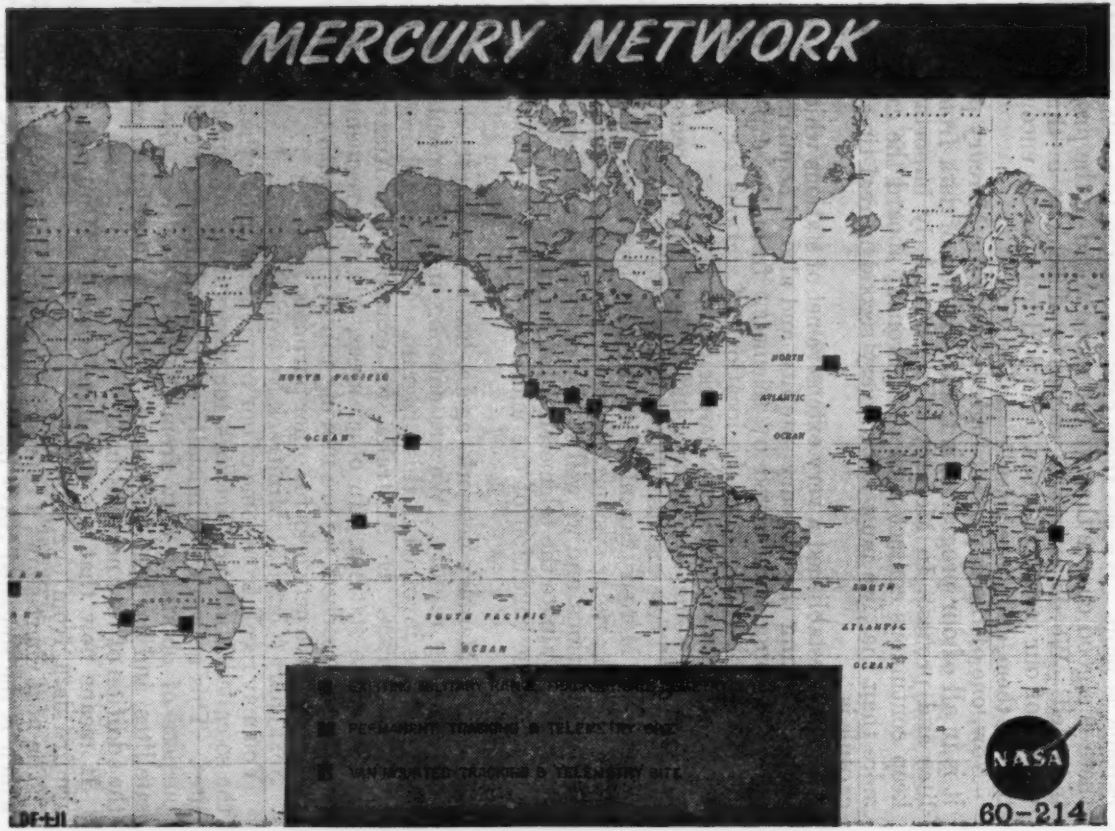


CHART 52

CHART 52

MINITRACK NETWORK
PRESENT FACILITIES
BLOSSOM POINT, MARYLAND
FORT MYERS, FLA.
SAN DIEGO, CALIF.
ANTIGUA, W. I. F.
QUITO, ECUADOR
LIMA, PERU
ANTOFAGASTA, CHILE
SANTIAGO, CHILE
WOOMERA, AUSTRALIA
PLANNED FACILITIES
ST. JOHN'S, NEWFOUNDLAND
FAIRBANKS, ALASKA
E. GRAND FORKS, MINNESOTA
SOUTHERN ENGLAND
DF-7-14-59
REV. OCT '59
2647

CHART 53

SAO BAKER-NUNN CAMERAS

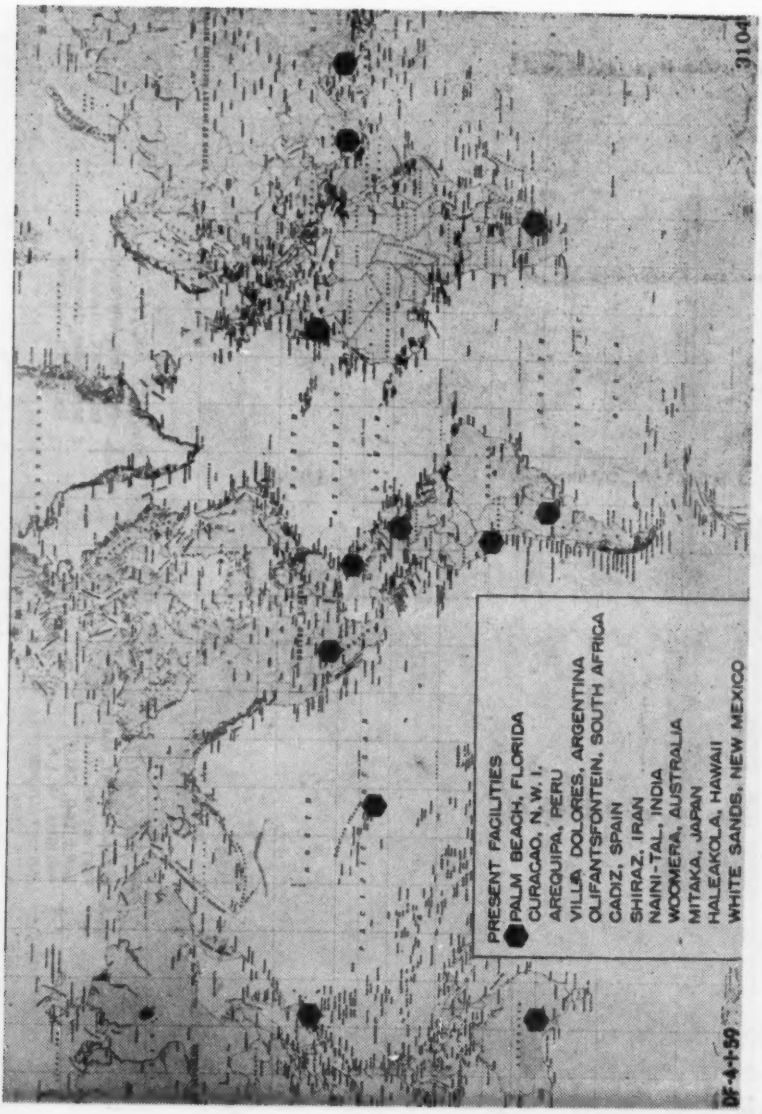
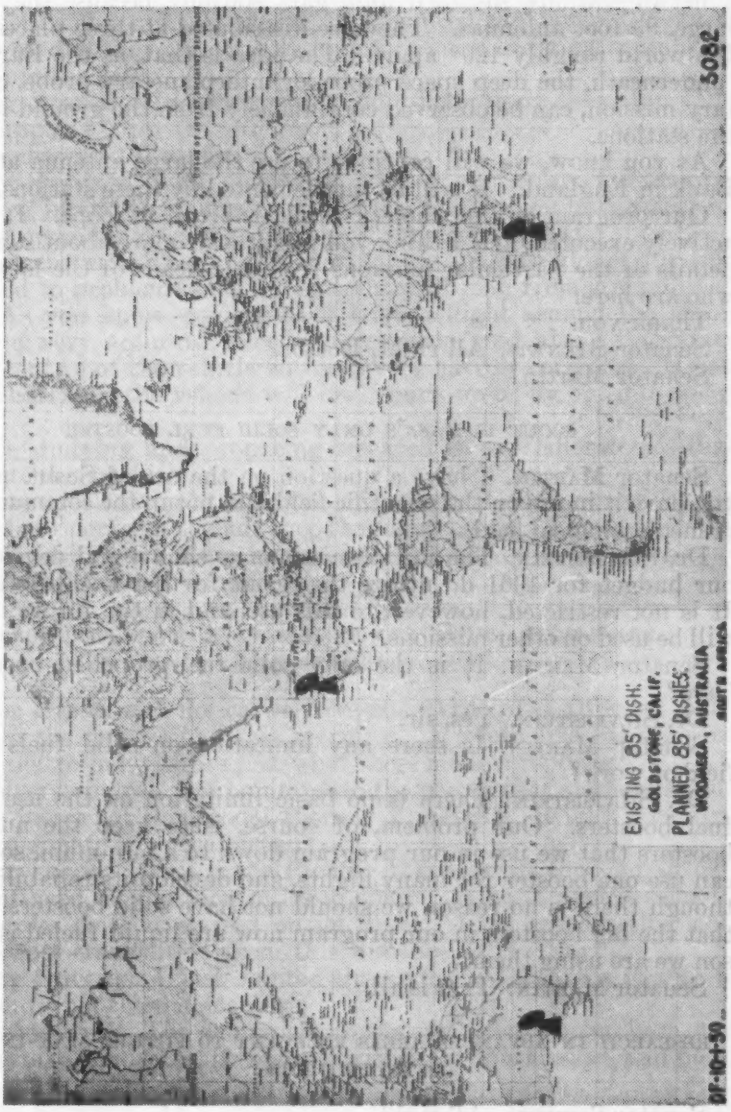


CHART 54

HIGH GAIN ANTENNA STATIONS



HIGH GAIN ANTENNA STATIONS FOR DEEP SPACE PROGRAM

We are currently developing, as a part of our deep space program, a net of stations, so-called high gain stations, because they involve large, 85-foot antennas. They are distributed at three places around the world roughly 120° apart. The idea is that, as the Earth turns underneath, the deep space probe, or interplanetary probe, or planetary mission, can be observed continuously from the ground by one of the stations.

As you know, we will continue to use the large antenna at Jodrell Bank in England. It will be supplemented by these stations.

Our program on the whole, I think, is broad in scope. It is being actively executed, and I think you might hear more about some of the details of the particular missions from our heads of the laboratories who are here.

Thank you.

Senator STENNIS. All right, Doctor.

Senator Martin?

SCOUT IS NASA'S ONLY SOLID FUEL BOOSTER

Senator MARTIN. I have a question on the use of Scout. I notice you have it in use on the scientific field and not in the communications or meteorological field.

Dr. SILVERSTEIN. The initial missions as shown and developed for our budget for 1961 do utilize the Scout for the scientific missions. It is not restricted, however, to this use, and in the future no doubt will be used on other missions.

Senator MARTIN. It is the only solid-fuel-propelled booster you have?

Dr. SILVERSTEIN. Yes, sir.

Senator MARTIN. Is there any limitation on solid fuels in your field of work?

Dr. SILVERSTEIN. There is no basic limitation on the use of solid fuel boosters. Our problem, of course, is to keep the number of boosters that we use in our program down to a minimum, so that we can use one booster for many flights, and develop its reliability. Although there is no reason we should not have solid boosters, the fact that the big boosters in our program now are liquid-fueled is the reason we are using them.

Senator MARTIN. That is all.

RESEARCH IN ADVANCED AREAS RELEVANT TO FUTURE MAN-IN-SPACE PROJECTS

Senator STENNIS. All right.

I have one question, Doctor.

According to our budget justifications, you have only $2 million now in the program for studies of manned space flights beyond Project Mercury.

In view of the importance of the manned space flights, will this permit you to do the proper planning? That is a very small amount of money in comparison with the total amount of $107 in your request for manned space flight.

Dr. SILVERSTEIN. Yes, sir. If that were the only funding available, it would be very small. However, you recall that we have available to our space flight program the use of other facilities in the NASA. One of the important areas of the advanced research group, shown on this chart, is a study of the advanced problems of manned space flight, and they are actively helping us and assisting us in looking ahead in the field.

Senator STENNIS. In other words, you draw upon them for your needed support?

Dr. SILVERSTEIN. Yes, sir.

Senator STENNIS. Well, now, what types of studies are you making and do you intend to make along this line, and do you have sufficient money to make the ones that you think should be made?

Dr. SILVERSTEIN. The studies that we are making along this line are related to problems such as the reentry of man from circumlunar flight. As you know, coming back from a flight around the Moon involves a very accurate piece of navigation, and also an accurate piece of control of the vehicle within a very narrow corridor. If you miss the corridor, the vehicle will itself burn up or fly out into space again.

We are studying and preparing research in our laboratories that investigate this problem.

Also, we are looking at the type of configurations we need in our spacecraft to perform the advanced measurements. This they do by the use of facilities that are in some cases unique to the research centers, and which must be done there.

EXACT DUPLICATE OF PIONEER V AND OTHER MODELS ARE DEMONSTRATED

Senator STENNIS. I notice we have somewhat of a different audience from the one we had this morning. I would like for someone to point out to our visitors just what these models represent.

Dr. Silverstein, can you point out to the people that are here as our audience just what this model Pioneer V means? It isn't necessary for you to go into any great detail.

Dr. SILVERSTEIN. This is the Pioneer V spacecraft that is now out, as I mentioned, 2½ million miles in space. It has traveled some 24 million miles since it started on its flight. It is broadcasting now on its 5-watt transmitter from this distance to the Earth.

Senator STENNIS. I just wanted the audience to have a chance to understand what these items were.

Dr. SILVERSTEIN. The equipment in the satellite is shown here, and we might take time later, if someone wishes to come around, and point out each piece.

Senator STENNIS. As I understand, this model that you have been describing, that is a representation of the Pioneer V. It has now, as you said, traveled over 24 million miles, and is now over 2 million miles away from the Earth, is that correct?

Dr. SILVERSTEIN. Yes, sir. This is an actual satellite. It is the duplicate of the one we fired. We always have two on hand when we fire, so if something goes wrong at the last minute, we can interchange them.

Senator STENNIS. So this that I have been referring to as a model is an actual satellite?

Dr. SILVERSTEIN. That is correct.

Senator STENNIS. Now, where are the paddle wheels we read in the paper about?

Dr. SILVERSTEIN. We have those here and will install them at lunch time.

Senator STENNIS. They fit upon these hooks or arms that you see sticking out, is that correct?

Dr. SILVERSTEIN. Yes, sir.

Senator STENNIS. All right. Now what about this tall model here on the table?

Dr. SILVERSTEIN. Dr. von Braun should describe this. Is he still here? If he is not here, I can.

Senator STENNIS. Just go ahead, give the audience a few words.

Dr. SILVERSTEIN. This is the Saturn vehicle made up with these eight engines at the base. The tanks are shown here. This is the first stage up to this point. On top of it we have the second stage. And in the second stage we use liquid oxygen and hydrogen, new propellants, for the actual propulsion of the vehicle.

On top of that we have a third stage which goes from here to here, and on top of that the fourth stage [indicating]. Now, this model breaks down. Here you see the engines in the stage that are used to propel the vehicle through space.

This vehicle is a part of the Saturn—this is the Saturn development which is being conducted by Dr. von Braun's group at Huntsville.

There is a man shown here, so you get an idea of the relative size of the vehicle and the man by comparison.

Senator STENNIS. All right. Well, I thank you very much for making that explanation.

Now, Senator Martin, do you have something further?

COMMUNICATION WITH PIONEER V

Senator MARTIN. How long do you anticipate being able to receive messages from the Pioneer V?

Dr. SILVERSTEIN. We estimate we will be able to hear from the current transmitter, which has a 5-watt output, for some 8 million to 10 million miles. If, when we turn on our larger transmitter and it operates, but we have not tried it yet, we should hear out 40 million to 50 million miles in space.

Senator STENNIS. Now, I want to take an inventory of our time. This afternoon we propose to meet at 2 o'clock, if that is all right with the committee. At that time we will have Dr. Pickering and Mr. Goett. And also we will have some more questions perhaps for Mr. Horner, who was here yesterday also. Is it agreeable to meet at 2 o'clock? Will it be agreeable to the witness?

Mr. HORNER. Yes, sir.

Senator STENNIS. All right. We want to specially thank you all for your testimony.

We want to thank you for your testimony and for your attention here this morning. We would be glad to have you gentlemen come

back this afternoon, if you would like to, but of course you do not have to.

Now for anyone who might be interested, when we do recess, I would like for them to come forward and have a chance to take a little closer view of these models here. One of these is an actual satellite. It is not a model. It is a satellite itself. And the other one is a model of the Saturn vehicle.

So come around, and if anyone wants to examine these models you will have someone here to explain them in part at least.

Tomorrow we expect to have Dr. York, and also General Schriever.

All right, if there is nothing further, the committee will take a recess until 2 o'clock.

(Whereupon, at 12:15 p.m., the subcommittee recessed, to reconvene at 2 o'clock on the same day.

AFTERNOON SESSION

Senator STENNIS. All right. The committee will please come to order.

For the benefit of all those who wish to hear the proceedings, it would be helpful if everyone tries to be as quiet as possible. I hope we have the loudspeakers working. Otherwise, people in the rear cannot hear at all.

Our first witness will be Dr. William H. Pickering, who is the Director of the Jet Propulsion Laboratory, at Pasadena, Calif. As I understand it, Doctor, you have charge of and relate your work directly to lunar and interplanetary activities.

I understand, members of the committee, that Dr. Pickering has flown here from California to give us the benefit of his testimony, which involved an all-night flight. We appreciate very much your presence here, and your testimony we know will be valuable.

You come very well recommended by your general reputation, as well as by some individual Senators who have talked to me about you, including Senator Henry Jackson, on the Armed Services Committee. We call him our Mr. Missile there.

We are glad to have you here, Doctor. I don't know whether you have a prepared statement or not. But it is not necessary. We are going to ask you to proceed in your own way, after being first sworn.

Doctor Pickering and Mr. Goett.

Do each of you solemnly swear that your testimony before this committee today and hereafter today will be the truth, the whole truth, and nothing but the truth, so help you God?

Dr. PICKERING. I do.

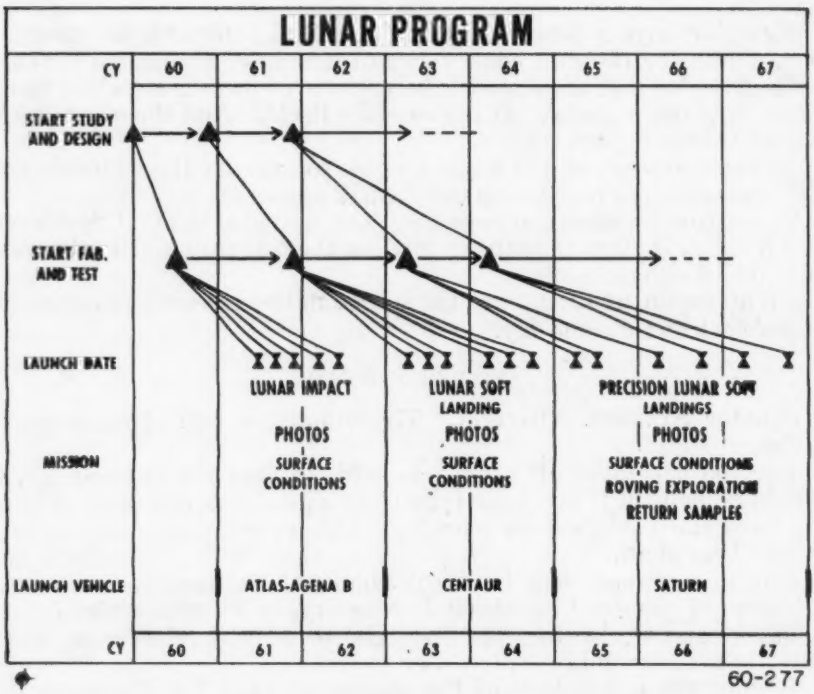
Mr. GOETT. I do.

TESTIMONY OF DR. WILLIAM H. PICKERING, DIRECTOR, NASA-CAL TECH JET PROPULSION LABORATORY

Dr. PICKERING. Mr. Chairman, as you said, my laboratory is concerned with the lunar and interplanetary programs. I would like first to describe the nature of these programs as they are now evolving within the overall NASA picture.

I think I will refer, first, to my first chart on the lunar program. (Chart 55, Lunar Program.)

CHART 55



EXPLANATION OF LUNAR EXPLORATION PROGRAM

I would like to point out several features of this program.

First of all, you see, down on the bottom line, the launch vehicles goes from the Atlas-Agena to the Centaur to the Saturn. Over a period of time, we increase our capability of delivering heavier payloads to the Moon. In a general way, we can say that the Atlas-Agena will deliver a payload somewhere between 500 and 1,000 pounds; the Centaur, perhaps, 2,000 pounds; and the Saturn, perhaps, 10,000 pounds.

So, in a general way, we go from about 1,000 pounds to about 10,000 pounds over this period of time.

As we have the capability of delivering heavier payloads to the Moon, we can perform more complex experiments. And that is indicated by the missions, the second line from the bottom.

With the Atlas-Agena B, we do relatively simple experiments. With the Centaur, we begin to talk about lunar soft landings—that is to say, landing instruments on the Moon with a relatively gentle or no landing shock, so that we can land relatively complex instruments and have them operate. And on the Saturn, we can talk about precision soft landings, picking the spot on the Moon, landing more delicate instruments, perhaps having roving exploration, a tank of some sort leaving the rocket and roving around the Moon to explore the surface, and perhaps we may even return samples from the Moon by a rocket fired back to the Earth.

Now, the other feature of this chart I would like to indicate is the leadtime required in these activities. You see, for example, in the Atlas-Agena B at the present time we are working now on the design, and by about the middle of the year we will begin fabrication and testing. We will conduct a series of five launchings during 1961 and 1962 as indicated on the chart.

For the Centaur, study and design has to begin before the end of 1960, and for the Saturn before the end of 1961.

These may look like relatively long leadtimes, but we are asking for complex engineering problems to be solved when we talk about spacecraft to perform these sorts of functions.

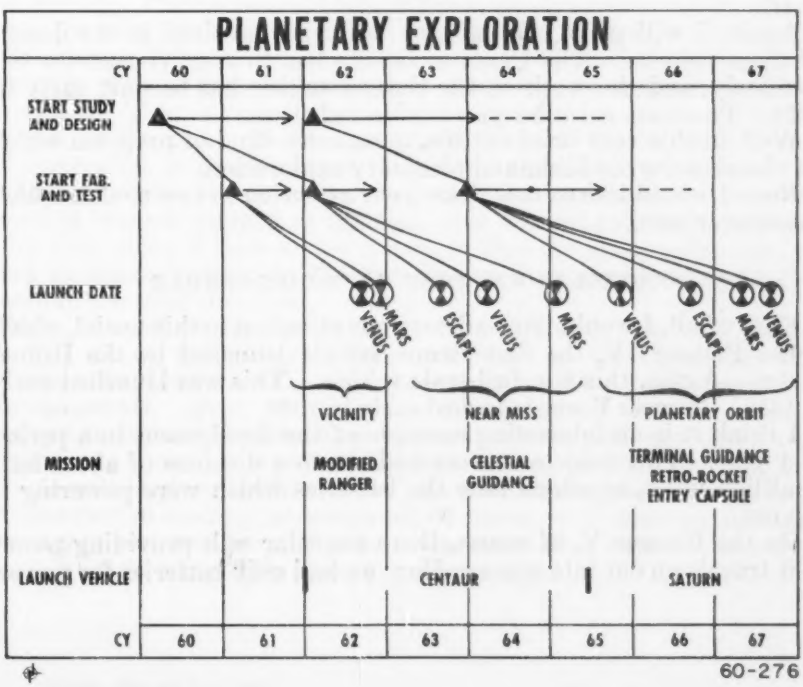
In other words, the spacecraft itself is now becoming a complex vehicle. It has guidance, it has propulsion, it has communications, it has telemetering, and so forth. The spacecraft is just as complex as a guided missile. And as we get to these larger spacecraft, we do have to solve difficult engineering problems, and accordingly we have these long leadtimes.

PLANETARY PROGRAM RESTRICTED TO CERTAIN DATES

On the next chart I have a planetary program indicated. (Chart 56, Planetary Exploration.) Again, the Centaur and Saturn are the vehicles.

Now, the planetary program is more limited than the lunar program, because the firing dates are determined by the relative positions of the planets and of the earth. There are only certain dates, certain astronomical dates on which you can fire.

CHART 56



The dates indicated there show you can launch toward Venus about every year and a half, and toward Mars about every 2 years. This indicates that at the end of 1962 there is an opportunity to launch both toward Venus and toward Mars, and this, then, would be an opportunity to use the Centaur vehicle with a modified lunar Agena B payload to be carried to the planets. Again, of course, as we go from the Centaur to the Saturn, the payload capability increases from the order of 1,000 pounds to the order of a few thousand pounds.

On this chart, in addition to the actual Venus and Mars planetary shots there are two others indicated as escape shots. These would be test firings of the nature of Pioneer V, where the complete system is checked out, but where you do not put on a restriction to fire at the right time and in the right direction to go near one of the planets.

Also indicated on this chart, as time goes on, in addition to the larger payload capacity, the mission complexity can, of course, also increase, and we can come closer to the planets as time goes on. So that the first firings would be in the vicinity of the planets, where the vicinity may mean as much as a million miles away from the planets.

A near-miss may be somewhat less than 100,000 miles, and a planetary orbit, somewhere of the order of 1,000 miles away from the planet.

In the last series of Saturn planetary shots, we indicate terminal guidance, retrorockets, and an entry capsule. What this means is that after the spacecraft has reached the vicinity of the planet, we will throw out a capsule which will land on the planet, and during the process of landing, and perhaps after it has landed, it would relay its messages back to the spacecraft, and from the spacecraft back to Earth.

Again, I will point out the long leadtimes involved in the design of these vehicles. The Centaur vehicle has to start essentially immediately, and the work on the Saturn vehicle has to start early in 1962. Those are calendar years indicated there.

Well, in this very brief outline, then, is the kind of program which we visualize for our lunar and planetary exploration.

Now, I would like to now draw your attention to two models which I have over here.

PIONEER IV WAS FIRST U.S. ESCAPE VEHICLE

First of all, I would like to draw your attention to this model, which is the Pioneer IV, the first escape vehicle launched by the United States. Again, this is a full-scale vehicle. This was launched early in 1959. Pioneer V was launched early in 1960.

I think it is an interesting example of the devolpment in a period of 1 year. This vehicle was tracked out to a distance of about half a million miles, at which time the batteries which were powering it ran out.

On the Pioneer V, of course, there are solar cells providing power as it travels on out into space. Here we had only batteries for power.

The instrumentation, likewise, in this case is considerably simpler than in the case of Pioneer V. This did measure the radiations present between the Earth and the Moon. It gave us some very interesting data on the amount of radiation far distant from the Earth.

Senator STENNIS. Pardon me, Doctor. Pioneer IV is still traveling, but you don't get signals any more?

Dr. PICKERING. Yes, that is right. This is in orbit around the Sun, just as Pioneer V is. The orbit of Pioneer IV is closer to the Earth's orbit than Pioneer V. It goes outside about 20 million miles and inside about 10 million.

The other model I have here is a model of a spacecraft for the early Agena B lunar vehicles. This is, of course, a scale model.

Now, on this one, there are two panels to provide solar energy-solar batteries covering the panels. These will then be unfolded and collect the energy from the Sun in somewhat the same manner as Pioneer V.

Underneath here there is a radio antenna which will be pointed back toward the Earth. In this area here are boxes containing instruments. In addition to that, instrumentation can also be extended out on a boom to get at some distance away from the vehicle.

At the other end, we have again another radio antenna which is not highly directional like the one at this end, so we can have two radio systems. This one can work for signals coming from any direction, this one has to point at the Earth.

SIGNIFICANT WEIGHT INCREASE IN ADVANCED SPACECRAFT

Now, of the engineering advances between something like Pioneer V and this one, I think perhaps one of the most significant things, apart from the size, general scale, and weight of the thing—Pioneer V weighs about 100 pounds, this weighs about 800—one of the most interesting engineering differences is that this spacecraft will be stabilized. That is to say, the vertical axis of the spacecraft will be pointed at the Sun. In the case of the Pioneer V, the vehicle was spinning when it was launched, and it was stabilized by virtue of its spinning motion. In this case, we do not have spinning, but we will swivel it around, point it at the Sun, then we will roll it around and point this antenna back at the Earth, so that the spacecraft, then, is fixed in space, looking at the Sun in one direction, looking at the Earth in the other direction.

Now, then, if we want to perform the next step in the lunar series, we will set up something of this sort where as the spacecraft approaches the Moon we will have a rocket which will be fired away from the spacecraft. Now, at this time, the spacecraft will be coming straight in toward the Moon, so this retrorocket will slow down the instruments aboard this part of the vehicle here, and this much of the vehicle will land on the Moon, not in a soft landing, but at least in a nondestructive landing, as compared, of course, with what would happen if you just let it come in at a mile a second or half a mile a second—it would completely destroy the equipment.

But if we can land it at a few hundred miles an hour, then we can have instruments aboard this part of the spacecraft which will continue to operate after the landing.

So that with this basic spacecraft, the next step would be to make a lunar hard-landing capsule in this fashion.

The same basic spacecraft then could be used for the first shots toward Mars and Venus, where the geometry of the situation is a little different, but fundamentally we would do the same thing, putting on more solar panels in order to give a greater amount of electrical energy. Also, different types of instruments. For example, a spectroscope to study the surface of the planet could be mounted in this area here.

So that what I am illustrating is that we have the beginning of a family of spacecraft, and the attempt here is not to make a whole lot of different things. You see, so far there is no family relationship between these two. But in the future, we expect to build a family relationship as the vehicles develop.

This next chart (Chart 57, Rough-landing Spacecraft for Atlas Agena) is a conception of this lunar capsule being fired apart from the spacecraft, and landing on the Moon relatively easily.

The next chart, please (Chart 58, Spacecraft for Centaur Planetary probe).

Likewise, for a planetary probe, we would have fundamentally the same spacecraft approaching the same way, and observing the surface of the planet.

CHART 57

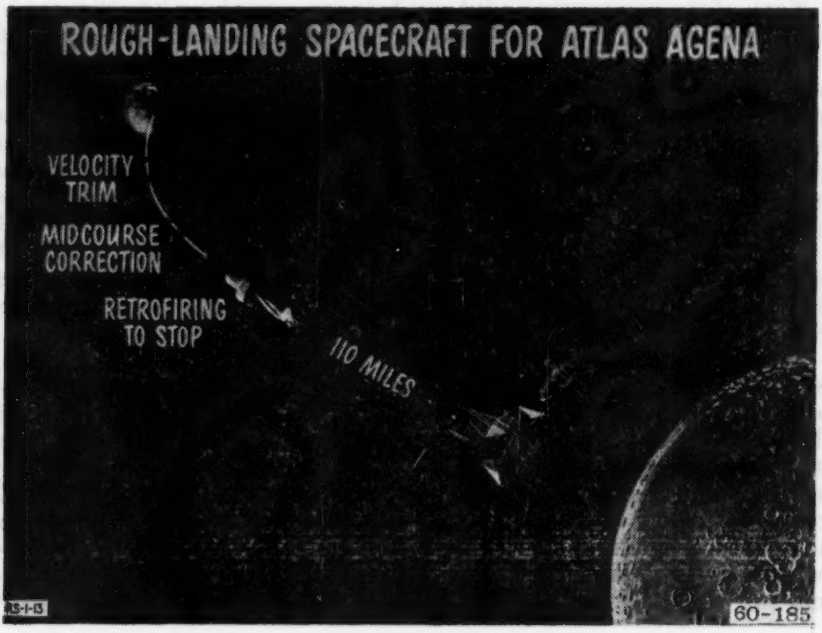
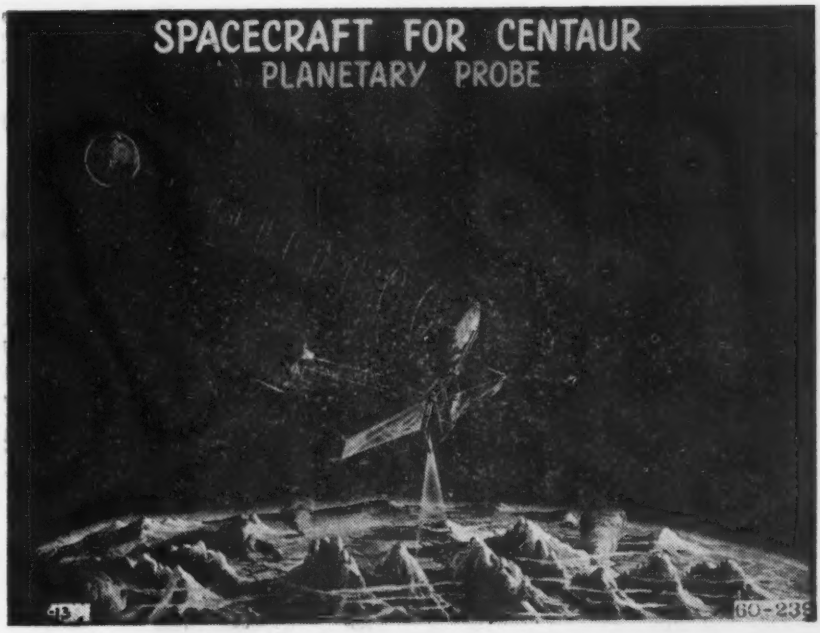


CHART 58



Next chart, please (Chart 59, Tracking Antenna, Goldstone, Calif.).

THREE-STATION DEEP SPACE TRACKING NETWORK

Now, there was mention this morning about the deep space tracking problem associated with the lunar and planetary programs. This is a graph of the station at Goldstone, about 100 miles from Los Angeles. This is the first of the 85-foot antennas which is being built to provide this deep space tracking capability for NASA. There will be three of these, as was pointed out this morning—one in Australia, one in South Africa, and this one in the United States. The three stations——

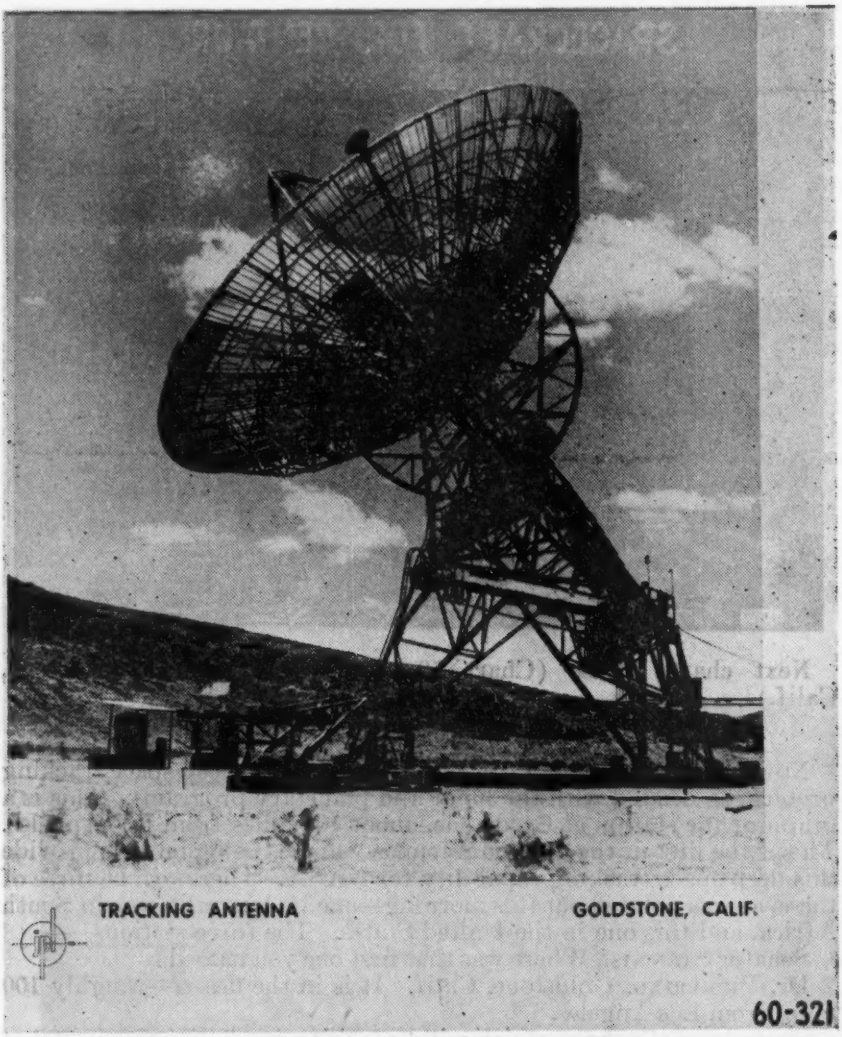
Senator STENNIS. Where was that first one you named?

Dr. PICKERING. Goldstone, Calif. It is in the desert—roughly 100 miles from Los Angeles.

So we have the three, which will be looking in all directions, so that as the Earth turns around, one or another will always be able to see the spacecraft.

This antenna—actually, there are two antennas of this type now in operation at Goldstone. This was the antenna which tracked Pioneer IV out to half a million miles. The next experiment they will be concerned with will be the Project Echo, where a balloon satellite will be used to reflect radio signals from this station to a station at the Bell Laboratories in New Jersey. The two antennas provide two-way communication. The two antennas can also be used to provide two-

CHART 59



way communications to the spacecraft at very great distances from the Earth, such as the distance of Venus.

Well, the Jet Propulsion Laboratory, then, is undertaking the design and development of this three-station deep space tracking network as part of our responsibilities for NASA.

CONTRIBUTIONS OF JET PROPULSION LABORATORY

Now, just in conclusion, I would like to just say a few words about the laboratory.

We developed the Pioneer IV at our laboratory, and also the Explorer I. Both Pioneer IV and Explorer I were flown in conjunction with Dr. von Braun's people, who provided the booster. We

provided the high-speed stages, which were solid rockets, developed at the laboratory, and then the instruments which were sent along, and the communications system used to communicate with the instruments.

The laboratory was transferred from Army support. This is a contract operation. The contracts had been with Army Ordnance. They were transferred, as you know, to NASA.

The laboratory is still conducting some work for the Army, which we are in the process of phasing out at this time. The specific project which we are working on is the Sergeant guided missile, which was developed by my laboratory.

The spacecraft assignment which we have received from NASA is a very logical assignment for this laboratory, because of its background in guided missiles systems development with the Corporal and Sergeant missile systems, because, as I said a while ago, the larger spacecraft begin to incorporate the problems of a guided missile—guidance, propulsion, communications, structures, and so forth—they are all there. And these talents do exist in the laboratory, and are fitting in very well to the assignment from NASA.

Mr. Chairman, I think that concludes my statement.

PIONEER V WAS DESIGNED TO OPERATE OPTIMALLY WITH BRITISH TRACKING STATION

Senator STENNIS. All right, Doctor. I read something in the paper that after Pioneer V, passes several million miles away from the Earth, that the only place the messages could be picked up was from some place in England. Could you clarify that for me?

Dr. PICKERING. Well, Mr. Chairman, the situation is essentially the following. At the time that Pioneer V was being proposed, which you remember involved a launching toward Venus, last June—that was the original objective—the question of the tracking of this instrument was considered and after discussing the matter between ourselves and the STL people and NASA, and the fact that the English have volunteered the use of their station at Manchester (Jodrell Bank), the conclusion was reached that the system would be designed to operate in an optimum fashion with the Manchester station.

The Goldstone Station at this time was still in process of being built. The Goldstone Station also was expected to be used for a variety of other tests.

Now, what has actually happened is that when Pioneer V was launched, the Goldstone Station tracked Pioneer V for a period of about 4 or 5 days, and data from Goldstone was transmitted into the system and was used in the calculations of the path of Pioneer V.

GOLDSTONE STATION HAS BUSY SCHEDULE

Likewise, the telemetering data was sent from Goldstone to STL. However, there was never any plan to use Goldstone to track Pioneer V indefinitely, because the Goldstone station at the moment is engaged in getting its setup for this Echo program, which will be launched within a month or so.

Our primary problem, then, was to be sure that we were in good condition, that we had checked out with Bell Laboratories on this.

And, incidentally, these checkouts have involved a number of experiments using the Moon as a reflector. So we have transmitted signals, for example, from Bell Laboratories to California by way of the Moon, with the Echo system. It turns out that the problem is not too different to use the Moon at 200,000 miles or the little balloon at about 1,000 miles. The radio problem turns out to be about the same.

So we have been conducting experiments using the Moon. And the problem is just that Goldstone is tied up on these Echo experiments at this time, and there was never any plan to use Goldstone for tracking of these great distances.

Now, as time goes on, if it seems desirable, and if the Echo experiments are completed, it would be quite practical to use the Goldstone station to track this vehicle at many millions of miles range, although I should point out that the selection of frequencies which was made for this vehicle was made to match with the capability of the Manchester station.

It turns out that for technical reasons the Manchester station cannot use the very high frequencies which are really desirable for these purposes, for which the Goldstone station is designed.

So I think the situation in a nutshell is that it was planned this way. It is a fine example of international cooperation. The British were willing to divert their radio astronomy antenna for this purpose. And from the technical point of view, either antenna could have done the job. In fact, the Goldstone antenna is expected to track to the same distances in the quite near future.

Senator STENNIS. Well, I thank you for that explanation. And if I understand it correctly, it is not a failure on our part, but this was conceived, originated, and planned from its inception to happen just as it is happening.

Dr. PICKERING. Yes, sir, that is correct.

Senator STENNIS. Now, how far out could you hear, utilizing this Goldstone Station?

Dr. PICKERING. Well, sir, this problem has to be looked at—I mean one has to put some conditions on an answer to that question, because, let me say, it depends on the transmitter power, and it depends on the amount of information which you are going to transmit. If you just want to know the signal is there, that is one thing. If you want to transmit a television signal, that is something entirely different. And so, if one says the minimum amount of information, then the Goldstone Station could track right now beyond the distance to Venus or to Mars. In fact, within a year or perhaps 2 years, we would expect the Goldstone Station to be able to track to the edge of the solar system.

Senator STENNIS. To the edge of what?

Dr. PICKERING. The edge of the solar system, which is a long way farther than Mars.

But the utilization of the Goldstone Station will be to follow along as needed in the lunar and planetary programs, so that in 1961 it will be used for tracking these vehicles, which go to the Moon.

For 1962, the Mars and Venus shots at the end of 1962 will be tracked from there. And so it will go. And as the shots get more complex, you have to transmit more information to take advantage of

the capability of the shot, and therefore the communication capability has to be increased with time, also, and the Goldstone Station is planned to increase in this capability with time.

DR. PICKERING WOULD LIKE TO USE JODRELL BANK RADIOTELESCOPE AS LONG AS THE BRITISH WISH TO MAKE IT AVAILABLE

Senator STENNIS. I assume the same reasoning would apply to the Manchester station. Are you expecting to use it now to obtain information?

Dr. PICKERING. Well, as far as I am concerned, I would like to see the Manchester Station (Jodrell Bank) used as long as the British wish to make it available.

Senator STENNIS. I mean how much longer on Pioneer V?

Dr. PICKERING. It should track Pioneer V out to the distance of Venus, or thereabouts.

Senator STENNIS. Do you have any money in this 1961 budget to expand or extend this Goldstone Station?

Dr. PICKERING. Yes, there is. In other words, the three-station network which is being talked about only exists as a single station so far. In fact, the single Goldstone Station is not up to its complete capability yet.

Senator STENNIS. Well, is this an appreciable extension and expansion of the Goldstone Station, the money that is in the 1961 budget?

Dr. PICKERING. No, there is not a great deal of extension of Goldstone in 1961. It will be mostly completed with the two stations.

TRACKING NETWORK WILL BE CONTINUOUSLY IMPROVED

Senator STENNIS. Well, do you need or plan to ask for more funds for this purpose any time soon?

Dr. PICKERING. Yes, sir, there will be a continuing improvement, an upgrading of these stations. In other words, we are asking this equipment to be right on the edge of the state of the art; and, therefore, this must be the best communication system, long-distance communication system, which we can build. And we will expect then to have to continually improve it.

Senator STENNIS. Well, it seems like we are in this business to stay, and it just seems as a practical matter that you need to have the development of these stations staying a little ahead of the rest of your program.

Dr. PICKERING. Yes, sir, we would like to be able to communicate as far as the rockets can throw the payloads.

Of the three stations we regard Goldstone as the research station, and as equipments are developed at Goldstone they will be shipped out to Australia and South Africa.

Senator STENNIS. So you have in mind, then, an expanded and extended program for these stations of ours that will follow your instruments out in space?

Dr. PICKERING. Yes, sir.

Senator STENNIS. All right.

To make the record clear here, NASA owns the facilities, but you are really with the California Institute of Technology?

Dr. PICKERING. Yes, sir.

Senator STENNIS. And this work is done with NASA on a contractual basis; is that right?

Dr. PICKERING. Yes, sir.

Senator STENNIS. How much is in this budget for additional facilities for the Jet Propulsion Laboratory?

Dr. PICKERING. $5 million in fiscal 1961. There is additionally some money for the deep space net, totaling $8 million—$8 million for the deep space, and $5 million for the laboratory.

Senator STENNIS. All right.

For the benefit of those who are in the audience I think it is very unusual for any group to get to see an exact duplicate of this Pioneer V that is actually in motion now.

Doctor, to make it clear to our audience here, this instrument on the floor with the paddle wheels, that is an actual duplicate of the Pioneer V that is now in motion over 2½ million miles from the Earth; is that right?

Dr. PICKERING. Yes, sir; this is an exact duplicate of the Pioneer V. And this is an exact duplicate of the Pioneer IV.

Senator STENNIS. These paddle wheels that show up in blue, they are out in space absorbing light from the Sun and generating energy; is that correct?

Dr. PICKERING. Generating electrical energy; yes, sir.

Senator STENNIS. And through that electrical energy you get the power to send back the messages; is that right?

Dr. PICKERING. Yes, sir. Mr. Goett will discuss the instruments on the Pioneer V a little later.

Senator STENNIS. All right.

I just wanted the audience here to get the benefit of seeing this.

Senator Martin, do you have some questions?

Senator MARTIN. Along the line of Senator Stennis' discussion, the money that you are looking forward to in our present budget has to do with parts of the project, and not the general project that is outlined above there on the chart, on the lunar program?

Dr. PICKERING. Parts of it; yes, sir. The fiscal 1961 expenditures—we do not have the total project costs in here; no, sir. But in fiscal 1961 you notice that the major part of the expense of the lunar program is associated with the Atlas Agena B vehicles. But some work has begun already on the Centaur vehicles—some planning work. So funds to provide that are included.

Senator MARTIN. This chart up here is on a calendar basis?

Dr. PICKERING. Yes, sir.

Senator MARTIN. And this subcommittee is considering funds for next fiscal year ending June 30, 1961.

Dr. PICKERING. Yes, sir. That includes, you see, fabrication of parts for the Agena, and study of the Centaur; so that the largest part of the expenditures are associated with the Agena.

Senator MARTIN. A very essential approach to the general project, however?

Dr. PICKERING. Yes, sir. It is essential that we have a continuing growing program, that we don't regard these as isolated projects.

RADIO SIGNALS WILL BE USED TO TRANSMIT DATA GREAT DISTANCES

Senator MARTIN. When you launch toward Venus or Mars in 1962, how far away from the Earth are they?

Dr. PICKERING. It is approximately 26 million miles from Earth's orbit to Venus' orbit and 49 million miles from the Earth's orbit to Mars' orbit. A probe in an elliptical orbit sent in to Venus' orbit would reach a maximum distance of approximately 186 million miles from the Earth and one sent out to Mars would reach a maximum distance of approximately 235 million miles from Earth.

Senator MARTIN. How far is it out to the outer reaches you mentioned a moment ago?

Dr. PICKERING. It is about 3.7 billion miles to Pluto.

Senator MARTIN. How are we going to get the information back?

Dr. PICKERING. Just by a radio signal, which travels that great distance. The radio signal will contain increasing amounts of information on it.

For example, if you look at the lunar program there, you talk about photographs of lunar soft landings.

Now, a photograph, of course, has to be sent back by some sort of a facsimile or television system. So that in essence, we can say that the requirement is that we have television to the Moon, say, in the Centaur program, in the 1963–64 period. And this is a great deal more communication than we have with simple vehicles like Pioneer IV or Pioneer V.

Senator MARTIN. Are we going to have adequate equipment to retrieve the data?

Dr. PICKERING. Yes, sir, we believe so. I think the fact that there is a tremendous amount of data is sometimes overlooked in thinking about these programs. But if we take these more complex spacecraft, and we fly them out for months toward Venus, or even take Pioneer V, on its flight—there is a tremendous amount of data being generated. The more complex they get the more data is generated. And, therefore, we must have means to properly utilize this data on the Earth. So that, for example, on a deep space net, we would have to have provision for a worldwide communications system associated with the net to relay data back to the United States and analyze it in some automatic fashion, in order to make proper use of it. Otherwise, we would just be completely swamped with data.

PAYLOADS OF SPACE MISSIONS COMPARED

Senator MARTIN. Now, I have a question about the launching vehicles for Pioneers IV and V.

Dr. PICKERING. Pioneer IV was launched with the Jupiter and the upper stages consisted of small solid propellant rockets, a cluster of them, which we provided from JPL. Pioneer V was launched with a Thor, basic booster, plus two upper stages, the second and third stages, one liquid and one solid. This is about 100 pounds; Pioneer IV is about 15 pounds.

Senation MARTIN. Now, the load coming up, you said, was about 800 pounds.

Dr. PICKERING. Yes. The spacecraft which appears on that first program is about 800 pounds.

Senator MARTIN. And what would the vehicle be?

Dr. PICKERING. The Atlas Agena. This is an Atlas, and then on top of it the Agena B, which is a vehicle which is being developed by the Air Force as part of their satellite program.

DR. PICKERING DOES NOT THINK SOVIET MOON PICTURES WERE A HOAX

Senator MARTIN. It has been claimed recently by one science writer that the Soviet Moon photos are a hoax. It came out in the newspaper here just very recently. What is your opinion on that?

Dr. PICKERING. My opinion is that they are genuine, they are not a hoax. I don't see any reason why the Russians would have tried to perpetrate such a hoax, because they know that sooner or later we are going to get pictures of the Moon, also, and I am sure that they wouldn't want to be shown up if they had perpetrated a hoax. Also, we are quite sure that the vehicles were launched in the direction of the Moon. We are quite sure that Lunik II impacted the Moon. And the Russian data which was being presented to us from Lunik III is quite convincing as far as I am concerned.

Senator MARTIN. Is there any very general division among scientists on that point?

Dr. PICKERING. I don't believe so, no, sir.

Senator MARTIN. They are mostly in agreement with you?

Dr. PICKERING. I think so.

Senator MARTIN. That is all.

Senator STENNIS. Thank you, Senator.

Senator Cannon?

SOVIETS HAVE BEEN FORTHRIGHT IN SAYING WHAT THEY WERE GOING TO DO AND THEN DOING IT

Senator CANNON. Thank you, Mr. Chairman. Doctor, as a matter of fact the evidence indicates that the Soviets have been very forthright in saying what they were going to do, and then doing that in this particular field, isn't that true?

Dr. PICKERING. Yes, sir.

Senator CANNON. Now, Doctor, on this one vehicle that you showed us over here on the stand, you talked about a retrorocket slowup to permit a landing—I think you called that a hard landing on the Moon?

Dr. PICKERING. Yes, sir.

INSTRUMENTS CAN BE DESIGNED TO SURVIVE HARD LANDINGS

Senator CANNON. How do you instrument it so that you can get the information back with the type of hard landing you describe?

Dr. PICKERING. Well, sir, you have to build pretty rugged instruments. But we think it can be done. In fact, we are conducting some experiments now, dropping instruments out of airplanes onto the desert, out in California, which we think looks approximately like the Moon. The landing speed we anticipate would be a few hundred miles per hour, which is a fairly rugged impact, true, but it still is not necessarily a destructive impact.

The difference between a hard landing and a soft landing is in the control of the rocket. In order to have a soft landing you must clearly navigate yourself down until you are just at rest when you reach the surface. Therefore, the retrorocket must be very carefully controlled, the system must be very carefully guided so you are coming in vertically and you are not moving across the surface. And this is a much more complex problem than a simple slowing down.

So looking at this program as an evolving program, we take the easy problem first, to get some experience with that, and then go into the more difficult one.

Senator CANNON. Now, what is the approximate speed prior to the separation and firing of the retrorocket of the object approaching the Moon?

Dr. PICKERING. The approach speed will be in the order of 3,000 or 4,000 feet per second, in that order of magnitude. And after firing the retrorocket, we hope to reduce that to 300 or 400 feet per second.

WHILE DR. PICKERING DIFFERS WITH DR. RAMO, HE IS NOT COMPLETELY SATISFIED WITH OUR SPACE PROGRAM

Senator CANNON. I think you stated in an interview with the Los Angeles Examiner that we have the capability of firing a rocket which was similar to the one that put up the Explorer a year and a half before sputnik. You also stated that we incorporated our satellite program as part of the International Geophysical Year, and this program was visualized by most scientists as being a low pressure, slow evolving effort.

Now, much has happened since that time. But now comments are being made that our space programs are being bogged down. Dr. Ramo recently stated that the United States has the industrial and the scientific capability to have space probes coming out of our ears. Instead, and I am quoting Dr. Ramo:

> • • • the Nation has not exploited that position to the fullest because we have become bogged down again with the real bottleneck, the slow process of decisionmaking, organization, and arrangementmaking.

Now, I wonder if you would care to comment as to whether you feel that that is the situation at the present time.

Dr. PICKERING. Well, sir, as far as space probes coming out of our ears are concerned, I think that if we look at the record, we have fired something like 15 successful probes, while the Russians have been firing 6, so, if you like, we have got space probes coming out of our ears. In other words, I would say we have indeed an active program in space, and a program which is paying off with increasing successful activity.

Now, of course, the big problem, it seems to me, from the public point of view, is associated with the fact of the size and of the propaganda aspects of the Russian space activities. They have only had six shots. Each one has been a significant advance over a previous one, and each one has been exploited to the full, as far as its propaganda value is concerned. But as I think Dr. von Braun said this morning, or Dr. Silverstein, from the scientific point of view the United States has contributed more useful space science than the Russians have. It is true that if we do have this difference in weight

lifting capability, it seems to me that we are fast catching up in that area, and that when I look at a program such as NASA is proposing here, I look at this lunar and planetary program which I am directly connected with, and I feel that this is a program which is moving along in a very satisfactory fashion, if it is conducted as outlined on those charts. And so I am afraid I differ with Dr. Ramo.

I don't mean to give the impression that I am completely satisfied with everything about our space program. One can always find problems. But I will say that the situation as it exists today is greatly improved, that the programs which are being planned are well thought out, are imaginative from an engineering viewpoint, and provide for a very satisfactory, well-integrated program.

If they are supported at the level needed to conduct these programs, then it would seem to me that we are doing very well.

Senator CANNON. In other words, you feel that we are not held up with a bottleneck because of the slow process of decision-making and the problems incident to organization and arrangement?

DR. PICKERING BELIEVES U.S. GOALS IN SPACE ARE WELL PLANNED

Dr. PICKERING. As you quoted me there, I have made the remark that we could have fired a satellite considerably before the time we fired the first Explorer. That is past history. Maybe there have been some troubles in the past. Maybe there have been some decisions which in retrospect were not the right decisions. But let's look at where we are now and where we are going.

I feel that decisions are being made, a program is being laid out. If the program is supported, then we will be doing very well.

Senator CANNON. Doctor, you stated before the American Rocket Society that we must establish our long-term goals in our space exploration programs, and then quit jumping every time the Russians fly another space experiment.

We must establish goals which are susceptible of engineering achievement, and which will provide significant and dramatic progress in space. Then it is also necessary for us to clarify management responsibilities and priorities in our space program.

Now do you feel that NASA is moving forward along those lines at the present time?

Dr. PICKERING. Yes, sir. I think as far as goals are concerned, that the sort of program which is being laid out here—and this, incidentally, is, of course, only part of the program—the satellite man in space program is in addition to this. But the goals which are being laid out I would regard as being very satisfactory from my point of view, that they are susceptible of engineering achievement, yes, sir; that they will require support to do this.

It is quite obvious this is an expensive program, and a program of increasing cost as the years roll by.

I am still somewhat concerned as to whether, as a nation, we understand our space program, and our total space effort, looking at both military and civilian, and ask ourselves why we are in this program, what we are doing it for, and whether or not we have a real understanding of this. This does bother me, and it bothers me from the point of view of whether or not we will continue to get support

for the program. In other words, if this program is to be supported at this level, it appears to me there must be a real understanding of the value of spending a billion dollars a year on space.

WE ARE IN A SPACE PROGRAM BECAUSE THE RUSSIANS ARE

Senator CANNON. Doctor, would you care to comment on why we are in this program?

Dr. PICKERING. Well, sir, in a word, I would say we are in this program because the Russians are. In other words, I would say that, as I said in my paper which you quoted, scientists during the IGY visualized the exploration of space as being a relatively slowly evolving exploration because of the costs associated with it. If we are going to be spending money of the order of a billion dollars a year for a NASA program, the incentives for the program have got to include more than just the scientific incentives.

From the scientist's point of view, of course, space is exceedingly interesting, exceedingly valuable. And space research is a most important part of scientific development.

But from the point of view of national policy, it seems to me that we must also recognize the cold war significance of the space program.

SCIENTISTS WANT A SPACE PROGRAM BUT CURRENT RATE IS BASED ON NATIONAL POLICY

Senator CANNON. In other words, the speed of the program is brought about by reasons of national policy and our international posture, rather than a scientific desire to achieve certain results because those results could be achieved in due time; is that what you are saying?

Dr. PICKERING. I don't like to say that the scientists would like to see a program slowed down, because, of course, quite obviously the scientists are interested in the results, and are fascinated in the possibilities of space, and would like to advance as rapidly as possible in space. Furthermore, they recognize that space is a new frontier, and we don't know where it is going to lead us scientifically, and engineeringwise, for that matter. And so from that point of view, the scientists welcome all the support they can get for space.

But it seems to me that the rate at which we are operating is indeed related to national policy.

Senator CANNON. In other words, the scientific requirement alone could not justify the speed that we are putting into the program at the present time?

Dr. PICKERING. I think if you asked most scientists what they would do with a billion dollars a year, they would not answer they would put it all in space.

COST ESTIMATE MAY RISE IN FUTURE

Senator CANNON. Now, Doctor, do you feel that the present funding for fiscal 1961 allows us to move ahead with sufficient speed in establishing these goals now that have been set up by NASA?

Dr. PICKERING. Well, sir, the problem is complex, because we are breaking new ground. This sort of thing has never been done before. We think we know how much it is going to cost. I hope these estimates are good. The ones which I have submitted I know, at least I think are good. But I must recognize the fact that in a new field of this sort, costs may indeed grow as we get further into the program. And all I am saying is that I believe these estimates are proper estimates for the program as it is now visualized, and for the effort as it is now visualized.

But, as we get further into the program, who can say?

Senator CANNON. In other words, you wouldn't want to be held to this statement at a later date, because of the possibility that the cost estimates may go up?

Dr. PICKERING. Yes, sir.

Senator CANNON. Thank you very much, Doctor.

Thank you, Mr. Chairman.

ABOUT 2,600 ON JPL PAYROLL UNDER CONTRACT TO NASA

Senator STENNIS. Thank you, Senator.

Back to your Jet Propulsion Laboratory for just a minute, and with reference to one particular problem you have, approximately how many people are employed at your Jet Propulsion Laboratory?

Dr. PICKERING. At the present time, there are about 2,600 on the payroll.

Senator STENNIS. And as we said awhile ago, that is on a contract basis?

Dr. PICKERING. Yes, sir.

Senator STENNIS. Now how many of those in top positions at the Jet Propulsion Laboratory command a salary in excess of what they could probably get if JPL were a Government installation?

What is the situation concerning your salary scale for these top positions, your scientists, we will say?

Dr. PICKERING. I would guess only three or four at the outside.

In other words, let me put it this way. Our salary structure is determined by the California Institute of Technology. We are part of the California institute, and our policies are determined by the institute. The fact is that most of my senior people have been offered jobs in industry at considerable advances over what I am paying them and, as far as I know, the civil service scales. I think it would turn out that very few were being paid significantly differently from what they would be on civil service.

Senator STENNIS. Let me be sure to understand now. Most of them are paid approximately the same amounts that they would be receiving on civil service, is that correct?

Dr. PICKERING. Without having facts or really making comparisons.

Senator STENNIS. That is your estimate?

Dr. PICKERING. Yes. As I say, I think the significant thing is that being associated with the California institute and having our salary structure established as a part of institute policy in general gives rise to a salary structure which is not as generous as an industrial salary structure, but nevertheless is satisfactory as far as our people are concerned.

ASSOCIATION WITH CALIFORNIA INSTITUTE OF TECHNOLOGY IS HIGHLY VALUED BY PERSONNEL AT JPL

Senator STENNIS. You don't feel any impediment, then? You are not operating at a disadvantage because of that problem?

Dr. PICKERING. No, sir. In fact, I think that most of my people would regard the association with the California institute as being a very valuable part of their employment.

Senator STENNIS. We had testimony here this morning about the operation of what was once called the Army Ballistic Missile Agency, the installation down at Huntsville, Ala. How would the situation be with reference to the Jet Propulsion Laboratory if it were operated as a NASA installation? What comment do you wish to make on that?

Dr. PICKERING. Well, sir, the comment I would make is that I am sure that a good many of my employees would look at the problem entirely differently if the link with the California institute was broken.

Senator STENNIS. Then they value highly the academic contacts and being a part of the California institute?

Dr. PICKERING. Yes, sir; they do indeed.

EDUCATION OF THE PUBLIC IS IMPORTANT PART OF THE SPACE PROGRAM

Senator STENNIS. Now, my attention is called to the fact that you have been quoted as saying some time recently that a part of your task is to educate the public and the Congress to the realities of a national space program.

I certainly think that you are correct about that. Just what means would you employ? Just what do you mean by the statement first, and then what means would you employ in bringing it about?

Dr. PICKERING. Well, sir, one of the things that bothers me about the public acceptance of space or the public view of the space program is that they find it difficult to sort out the engineering realities from the Buck Rogers aspects of space. In other words, the engineering problems which have to be solved are indeed difficult, and of a nature which have never been faced before.

Also, practically any feature of a spacecraft problem or a lunar landing problem, or you name it, are things which the public are all too inclined to brush off as being easy because science can do anything.

Well, science can do these things, but it takes time.

Senator STENNIS. Yes.

Dr. PICKERING. And I feel that this is one of the important things as far as the public is concerned, is to sort out the facts then from the fiction in space. I think that those of us who are associated with the program can do our part in trying to explain just what we are trying to do, and give some appreciation if we can of the complexities of what we are trying to do.

Senator STENNIS. I am excited about the possibilities in connection with weather and communications satellites. I think they are going to have a great impact on the business and social world. People will be more interested in what you are doing if you tell them about some

of the useful applications and some of the benefits that they are going to gain.

Dr. PICKERING. Yes, sir, I feel that space research will indeed be useful in practical applications as time goes on.

DISCUSSION OF NAVY'S 600-FOOT RADIOTELESCOPE NOW UNDER CONSTRUCTION IN SUGAR GROVE, W. VA.

Senator STENNIS. May we go back just a minute to this question? I want to ask you about the Navy's big 600-foot radiotelescope. Do you have any plans to utilize this radiotelescope?

I believe this is scheduled to be finished in 1962.

Dr. PICKERING. Yes, sir.

Senator STENNIS. Do you have any plans to utilize it in your program?

Dr. PICKERING. Well, I think that any of these antennas which can be used will be used to supplement the basic networks which are being established by NASA. Take for example the problem of, shall I say, the traffic capacity of a network. When we look at these programs, we are going to have lots of things transmitting signals to the Earth, and the networks are going to be saturated, and we are going to need to call on these other stations to supplement the networks from time to time, so that I visualize that the Navy station, the Manchester station, and perhaps other radio astronomy stations might very well be called upon to help out.

Senator STENNIS. Have you made any contact with the Navy though? Have you made any plans, any agreements, or any talk with them about the use of it?

Dr. PICKERING. There has been some discussion between NASA and the Navy. I am afraid I don't know the details of that.

Mr. HORNER. We have had preliminary discussions, Mr. Chairman. Inasmuch as the actual availability of the facility is probably more than 2 years off, considering the period for shakedown and learning how to use it, we do not have any definitive plans yet but we certainly will use it to the extent that it is available.

Senator STENNIS. It seems to me I remember we authorized that in the Armed Services Committee. There is a lot of money involved, and it seems to me that the time to make plans is now, talk to the Navy about what your needs are going to be and so forth.

Dr. PICKERING. Yes, sir.

Senator STENNIS. See if you can't utilize it.

Dr. PICKERING. They have other plans for the use of that dish too. One of the problems of course is that in conducting these space activities, you have to have tracking facilities available at the time you need them. For example, consider a vehicle which is going to land on the Moon. At the instant of landing on the Moon there must be a tracking station which is observing that landing. And so you put restrictions on other people's stations.

In other words, you must put the hour and the minute as a condition on the utilization in a good many cases.

Senator STENNIS. I know that is a possibility, but it seems to me this is advertised as the world's largest radiotelescope.

Dr. PICKERING. Yes, sir. Well, the radio astronomers have quite a number of these scattered around the world, and other radio astronomers are interested in these programs.

Senator STENNIS. If I may suggest, don't assume that they are going to be using it all the time or that you can't use it. My suggestion was very mild, that you just talk to them about it.

Dr. PICKERING. Yes, sir.

Senator STENNIS. See what they say and what the possibilities are. You have to have this tracking, I believe that is the term you use; you have to be able to get these messages back. Otherwise, there wouldn't be any practical worth in sending these vehicles into space; isn't that correct?

Dr. PICKERING. Yes, sir; that is correct.

Senator STENNIS. Senator Martin?

DR. PICKERING QUESTIONS WHETHER WE ARE PROPERLY MOTIVATING YOUNG PEOPLE TO GO INTO SCIENCE AND TECHNOLOGY

Senator MARTIN. Are you satisfied with the number of scientists coming out of our school system today?

Dr. PICKERING. Well, sir, sometimes I look at the figures of the United States vis-a-vis Russia in this regard, and I get disturbed because they have so many more technical people than we have and technical people of a higher caliber. This is not a diploma-mill operation but high caliber graduates. The thing that disturbs me is the question of whether or not we are properly motivating our young people to go into science and technology to the extent they should.

I don't feel that we should go as far as Russia. Russia apparently blocks out a very large percentage of their students for this sort of work, and obviously we should not do that.

But, on the other hand, I do feel that we should do our best to motivate our students to go into these areas.

Senator MARTIN. Have you observed the general experience of schools throughout the country, whether they are losing faculty members to industry to the point of limiting their ability to give the instruction to the number of young scientists we need?

Dr. PICKERING. I am sorry, sir, I just don't have any information on that. I have observed the situation at California Tech, where is it satisfactory, by the way. Cal Tech faculty is a first-class faculty. But I have no general information.

Senator MARTIN. That is all.

Senator STENNIS. All right, Senator. Thank you. Senator Cannon, do you have anything further of Dr. Pickering?

COURSES IN MATHEMATICS AND SCIENCE SHOULD BEGIN AT THE ELEMENTARY SCHOOL LEVEL

Senator CANNON. Just one further thing, Doctor. You say that we should motivate our young people further, and that is a pretty broad statement. I wonder do you have any specific thought as to how this motivation might be accomplished? I don't want to try to get you out of your field, but if you have any ideas on it I think it would be very helpful.

Dr. PICKERING. I feel that the starting point has got to be good courses in mathematics and science at the elementary school level. If you can get youngsters to develop their abilities in this area even before high school or certainly in the early days of high school, then I think you have a chance of maintaining their interest.

Of course, the problem which so many schools report is the fact that the youngsters regard these courses as difficult and they don't want to take them, and what to do about that, whether this is a problem for the counselors, the parents, or whom.

Senator CANNON. Would you say that those courses perhaps should be made requirements in many more instances, for the schools to take a second look and perhaps consider at least making those required courses?

Dr. PICKERING. I feel—yes. I would say the following: That within a decade or so the well-educated man must be knowledgeable in science. Right now, for that matter, he has got to be knowledgeable in science. And certainly looking into the future, as science and technology plays an increasing role in our everyday life, a man is not going to be well educated unless he understands something about science. Therefore I feel, yes, we should require this and require it very young.

Senator CANNON. Thank you, Doctor.

Senator STENNIS. Doctor, we certainly do thank you for your testimony here and for the fact that you could come and did come and could give us your attention and your time.

It is great work you gentlemen are doing. I wish I could go out and visit with you sometime so as to have a better understanding of your operations, your organization, and something about your work. We are most grateful to you.

We would be glad for you to stay. Otherwise, we will go on to the next witness now. Thank you again.

Dr. PICKERING. Thank you, sir.

Senator STENNIS. All right, Mr. Goett, will you come around, please?

We are glad to have you, sir. You heard what went on before. You are Director of the Goddard Space Fight Center and you are going to give us a discussion of these satellites, space probes, and so forth.

Mr. GOETT. Yes, sir.

Senator STENNIS. You do not have a formal written statement.

That is not necessary at all. You are especially welcome. Will you proceed in your own way.

STATEMENT OF HARRY GOETT, DIRECTOR, GODDARD SPACE FLIGHT CENTER, NASA

Mr. GOETT. I thought I would try to give you a picture here of how the Goddard Space Fight Center operates in executing its job within the NASA complex. You gather from what has previously been said that we are the payload people. We share with Dr. Pickering and JPL the job of putting together the payloads that will be launched by the launch vehicles. The particular part of the job

that we do is the scientific earth satellites which Dr. Silverstein described this morning, the application-type satellites, and by that I mean the meteorological satellite and communications satellite which will be of some application, immediate application use, and then also manned spacecraft. In other words, Project Mercury comes under our supervision.

GODDARD SPACE FLIGHT CENTER RESPONSIBLE FOR PROJECT MERCURY PAYLOAD

We are responsible for this payload, you might say, from the cradle to the grave, from its inception until it puts out its final data. This is a job of such magnitude and diversity that I think there is no one group or no one organization that can do it all. Our job is not to try and do it ourselves but to best use our capabilities along with those available throughout the country to accomplish this job. We are doing the job with the aid of some 200 prime contractors; of the budget that we are up for this year, some $145 million of this budget will be spent on outside contractors, industries, universities, and the like, in contrast with some $35 million which will be spent on our in-house work.

In setting up Goddard—and we are still in the process of setting it up, both in terms of manpower and facilities—our philosophy has been to use as much outside help from the university, scientific community field, and industry as is available, consistent with maintaining an in-house competence at Goddard, so that we can intelligently manage this job. I think Dr. von Braun had some words on this. You can't do this job just by reading a description of what is going to be done. In order to have any authority to manage anybody, you have to show that you have actually done it yourself in certain instances.

GODDARD ALSO HAS RESPONSIBILITY FOR 35 SATELLITE PAYLOADS AND 80 SOUNDING ROCKETS

Before I really describe how we do the job, I would like to first indicate a bit what it is. We find that we have responsibility for some 35 satellite payloads plus 80 sounding rockets. Of these satellite payloads I am talking about, some of them are already in orbit. Some are just one step beyond the gleam-in-the-eye stage, where we are actually putting the pencilmarks now down on the initial design. These missions vary so much in weight and complexity that it is not possible to take any one of them and say this is typical, this is how we do it. So what I have tried to do is to select from the 35 jobs plus the sounding rocket jobs that we have a representative group and put them up there on the chart. (Chart 60, Typical Goddard Missions.) As we read it from left to right, the first one on the left is a typical sounding rocket payload. Just to give you a feeling of its size and the like, there is one of them there with its cover taken off.

Senator STENNIS. The red and blue.

Mr. GOETT. Yes, sir; the first one. These sounding rockets, as Mr. Silverstein said, are launched generally vertically up to possibly as much as 4,000 miles, and in many cases carry the first prototype instruments that will later appear on more complicated missions.

CHART 60

The second paylcad shown on the chart is the Vanguard 3 satellite; there is a sister of that on the table. This is one of the spare payloads that was not used. This satellite was put in orbit last September.

Senator STENNIS. That is the large silver ball you are referring to now?

Mr. GOETT. Yes, sir. From September till December it transmitted data to the ground which we are now in the process of analyzing. I would like to describe it a little bit more in detail later.

The next one on the chart is Pioneer V here [pointing]. It happens that this is one job in which a maximum use was used of outside industry capability. I believe it was within a month after NACA joined in NASA that the actual contract was let for this particular vehicle which was launched just several weeks ago, and Goddard, which came into being still later, inherited the management part of this job.

The next one on the chart is Tiros which is one of these application satellites, a meteorological satellite. It will be launched shortly and if successful we will get from it our first good pictures of cloud cover (see note on Tiros on p. 31).

The next job shown is now in the thinking stage. It is the second generation meteorological satellite. It will in the first place require a heavier launching vehicle than is now available; it will be launched from a Thor-Agena, and will carry more sophisticated instrumentation.

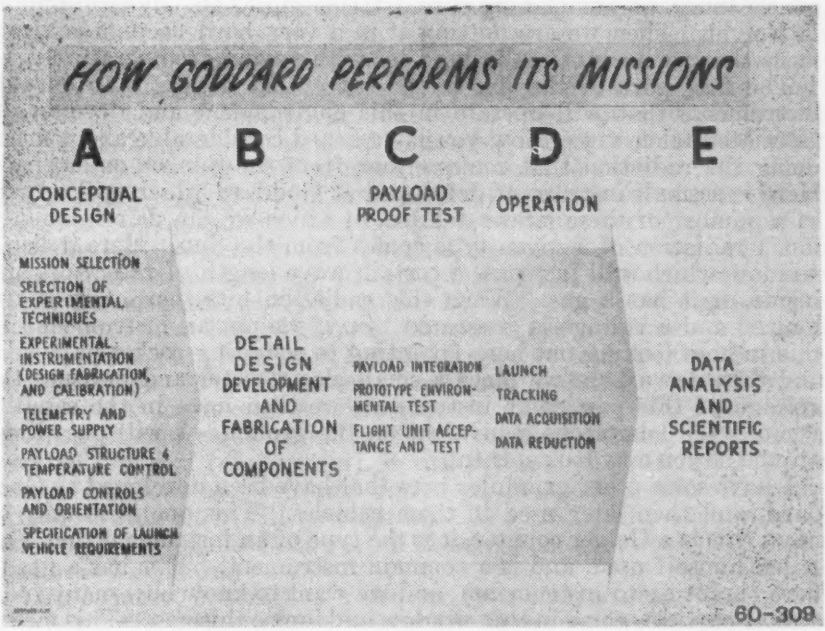
The next job is Project Mercury, which is the first manned space vehicle of which I think you have heard very much. And finally we are at the present in the initial design stage on the orbiting astronomical observatory. As you can see, there will be about a 3,000 pound vehicle which will be launched from an Atlas Agena. The same vehicle that will launch the spacecraft that Dr. Pickering talked about. But since this will just go into an Earth orbit rather than off

into space, it can be a lot heavier than the spacecraft. This is a job on which astronomical instruments will be put, and will take advantage of getting above the Earth's atmosphere, and looking at the radiation from the Sun and interstellar space. As I say, there is a total of 35 satellite payloads under Goddard management, some of which will be off the end of the chart; I thought this was a representative sample.

STEPS INVOLVED IN PERFORMANCE OF MISSION

Now regardless of whether it is a small job or a big one, each one of these involves about the same steps, which the next chart will show. (Chart 61, How Goddard Performs Its Missions.) In

CHART 61



any job we have to go through the process of the conceptual design. Then having completed that, running right across the chart the next step (B) is the detail design, development and fabrication. Then the payload proof test to see whether the conceptual design was in the first place correctly conceived and in the second place correctly executed. Next the launch, tracking and data acquisition and finally, the data analysis and preparation of scientific reports.

Now the major portion of the $145 million that I mentioned earlier that we will spend outside will be spent in that yellow area (pointing to step B, "detail design, development and fabrication" on chart). The major portion of the Goddard activity will be spent in the pink areas (pointing to steps A, C, D and E). For a very good reason, we feel that this is the place where we can maintain control of the job and make sure that we are getting what we want.

Instead of running down that chart step by step, I brought some examples of just what we have to do in each one of these phases and I would like to show them to you:

DEVELOPMENT OF INSTRUMENTATION AND TELEMETRY

The job of almost any one of these payloads can be divided into developing the scientific instruments that have to be put into it, and then developing the telemetering and power supply that are needed to send this information to the ground.

Now bear in mind that many of these experiments that we are doing are really experiments that heretofore have been done in an airconditioned laboratory under ideal circumstances. Here we are confronted with putting something like this on top of a rocket which is not a gentle thing, and subjecting it to extreme vibration. We are limited in weight. Then we are putting it in a very hard vacuum environment that we are not really used to, with varying temperatures.

The first part of the job in the conceptual design is to develop instruments that will operate in this environment and develop the associated telemetry. Now you have heard considerable about measuring the radiation that comes either from the Sun or outer space. Here is a small instrument developed at Goddard which will appear in a number of these later satellites, in which we can determine how much radiation of a given type comes from the Sun. Here it has a window which will just pass a certain wave length of radiation, and inside it, it has a gas. When this radiation hits there, this gas is ionized and a voltage is generated. So if we put an instrument like this in here looking out here (pointing to sounding rocket payload), and then down here we place a small electrometer and measure the voltage of this particular instrument, we then have in the satellite what is the laboratory equivalent on the ground. I will pass these around so you may look at them.

I have some other examples here that have been developed at Goddard, and then later used in these vehicles. This one is worthy of note; this is a Geiger counter, it is the type of an instrument that Van Allen himself used, and is a common instrument. This has a gas in here (pointing to instrument), and we want to know how many individual particles come in this window and ionize this gas. This means we have to measure the number of voltage pulses in this gas filled chamber. So here is a little rate meter which will measure the number of pulses that come in here. This is put right on here (pointing to payload) for this particular experiment.

Generally present payloads, those on sounding rockets, Pioneer V, this Vanguard III payload, are spinning, so whenever you make a measurement such as those I have described, you want to know whether the radiation that it is getting is coming from the Earth, the Moon or from interstellar space. So here we have a couple of instruments. This is an aspect sensor; every time this vehicle spins and looks at the Sun—a photoelectric tube in here—it will give a pulse which will be recorded so we will know when it is looking at the sun.

This instrument works on somewhat the same principle. It indicates when it is looking at the ground, so we will not only get the information from those radiation measuring instruments, but from

these aspect sensors, and will go through a correlation analysis which will tell us whether the particular pulse of radiation that the radiation instrument gets came from the Sun, or came from outer space, or the Earth.

Now so much for the scientific instrumentation. At Goddard we have a group of people who are versed in the particular scientific fields of gamma rays, atmospheric particles, magnetic fields and the like. These are the scientists for whom the data is to be gathered. They have to be supported then by people who will design the rest of this vehicle, both in terms of its structure and in terms of the telemetry that is necessary to transmit this stuff to the ground.

SEVERE WEIGHT RESTRICTIONS ON PAYLOADS

Once again we are confronted at present, and I think we are going to be confronted for some time, with the weight problem. So let's take as an example this particular Vanguard III vehicle, which incidentally was completely constructed by the group which joined Goddard from project Vanguard. There was a very severe restriction on weight, so the problem here was to develop a light, reliable telemetry system which would send quite a few channels of information. Here is a memory system which was developed, which takes the signals from various instruments and is capable of remembering the input of a number of channels on here (indicating a magnetic core), and then picking off as required 48 different channels of information. This particular magnetic core principle, which grew out of one group now at Goddard, has been designed into other space telemetry systems.

Before I depart from this, I would like to go back a little to the instrumentation. This instrument (on Vanguard III) gives information on the number of micrometeorites in space. Here is a little diaphragm, and right behind it is a microphone. Every time a little particle hits this (diaphragm), it will produce an electrical pulse on this microphone and indicate that there has been a micrometeorite hitting. This then will be recorded. We are finding that in the 3 months that Vanguard III was up in orbit, that about one particle hit this every 3 minutes.

The Pioneer V here has a similar type instrument. One of the things we would like to know is whether there are more mircometerites when you get away from the Earth or not. Here is the diagram on Pioneer V. Every time something hits here it will be recorded. This has two different microphones behind it. One of them will only record if there is a big hit and one of them will record if it is a little hit.

In developing a space technology, you have to know whether solar cells like that (on Pioneer V) are going to erode away and decrease in efficiency with time. We of course have solar cells up, and we are watching on that to see what happens to them. But (on Vanguard III) here is an erosion gage. This has a chrome coating, and if this chrome coating is eroded away, the resistance of this particular strip will go up. It will be recorded and we will then know the rate of erosion. We will be able on future vehicles to design protective covers for solar cells such as these (on Pioneer V).

Up here was a magnetometer (indicating on Vanguard III). In this particular case we combined with a company out on the west coast, Variun, in the development of this particular magnetometer. It flew on Vanguard III for 2 or 3 months and we got some 5,000 measurements of the magnetic field in its orbit down to an accuracy of about one-ten thousandth of the Earth's magnetic field right here. These data are being analyzed right now to give us information on what the characteristics of the Earth's field are and how it varies. A successor of this instrument with improvements will be flown on the spacecraft that Dr. Pickering described, so that this background of experience will also be applied on interplanetary missions.

Another part of the job that we have to do at Goddard is the structural design of these vehicles. We also have to at Goddard have people who are familiar with the orbital mechanics so that we can design trajectories that are adaptable to our experiments.

OTHER RESPONSIBILITIES IN DEVELOPMENT OF THE PAYLOAD

To pass on to section (B) (pointing to chart) quickly, in this particular area there is a fewer number of our people involved here, but these must be the senior people. These are the people who can be project managers, who can go out into industry and can command respect and also have sufficient judgment to come back and deal with the other doers at the laboratory and pick their brains and make sure that their knowledge is best applied to the work of the contractors.

Thirdly (pointing to section C on chart) there is this problem of taking the payload and determining whether its concept was correct. Right now we can ground test payloads of this size (pointing to Pioneer V). We can put them in thermal vacuum chambers. We can subject them to the temperature cycles that they will be subjected to in space. These right now are 4- by 6-foot chambers.

We are getting chambers that will enable us to take the next generation of vehicle, but our present budget request calls for a payload test facility which will enable us to put into a thermal vacuum chamber and check out a vehicle such as that orbiting astronomical observatory [pointing to chart]. We feel that we have to continue to have this capability, and that we have to continue to keep our payload testing capability one step ahead of the size of the payloads. I think almost everything you have heard today has indicated these payloads are going to get progressively larger. We also have a "satellite systems lab" listed as a C. & E. item in the budget request right now. As you can see, a satellite such as this [pointing to Vanguard III] can be assembled in a relatively small shop, but for the orbiting astronomical observatory which we are going to be assembling it, we will need bigger assembling facilities, and for the payloads that are going to have to be put on the Saturn vehicles are going to have to be still bigger. So we have to bear this in mind and the request for the satellite system lab is based on this need.

When we get down to the actual operation [pointing to section D on chart], our payload responsibility means we have to have a certain number of people down at Cape Canaveral to make sure that the payload is operating before the launch.

Senator STENNIS. I see you have an evolutionary process here far beyond what I had ever realized.

Mr. GOETT. I am glad that it is happening, as an evolutionary process.

GODDARD RESPONSIBILITY INCLUDES TRACKING EARTH ORBITING VEHICLES

When the vehicle is launched [pointing to chart] our responsibility includes tracking the Earth orbiting vehicles; JPL tracks the deep space probes. For our part of the job, as you know, we have the Minitrack network. We have a north-south fence; once every orbit an east-west orbit passes over it. We are completing an east-west fence so that the north-south orbits will pass over it. At each one of these stations we have equipment for recording the data. Then these data are sent (or will be sent when we get into operation out at Greenbelt in the next 3 or 4 months) to a central data reduction facility at Goddard, where we have the equipment to decode it and put it into a form which the scientists will use for their analysis.

I would just like to show you one gadget that is used in this data acquisition task. We have the choice of putting ground receiving stations throughout the world, having many of them or alternatively of recording the data and then when it passes your one station on each orbit, to interrogate the vehicle and take out the data that was recorded. Here is a tape recorder which will go one one of the late Tiros vehicles. This Tiros will take cloud pictures and it will be possible for this particular tape recorder to take 100 minutes of data and for this data then to be stored and read out in the 3 minutes that the payload takes to pass over a station. In this way we use one station instead of many stations. (See note on Tiros on p. 31.)

DATA ANALYSIS AND REPORTING

The final step in our payload job is the data analysis and reporting—step E on chart. We find that we are dealing with some 50 different experimenters in this data analysis and in preparation of the scientific reports; many of them are at Goddard, many others from the scientific community. It is Goddard's job to aid and abet them in this last step; we keep in contact with the scientific community to see that the needs of the individual experimenters are being properly taken care of.

I think that about concludes my presentation. It was my intent here to emphasize in the first place the diversity of the type of work that we are doing to show what type of personnel and facilities we need at the center. The second point is that although we are at present capable of handling payloads on these smaller vehicles, we do need a continuing and a growing capability for testing the larger payloads that we sure are going to be operating with.

MICROMETEORITES HAVE THUS FAR CAUSED LITTLE DAMAGE

Senator CANNON. Mr. Goett, you mentioned the recording device that records the contact of these vehicles with objects in outer space.

How strong are those contacts? Do they do damage to these vehicles on occasion?

Mr. GOETT. No, they are very light contacts, the ones that we have recorded. To our knowledge we have not yet recorded any contacts that do significant damage.

Senator CANNON. And are these vehicles particularly tough in character? Would they take a considerable amount of punishment?

Mr. GOETT. No, I don't think so. I think that we just haven't run into any big objects and the probability is that we won't. What we are presently concerned with is the smaller objects and to what extent they will erode away on a solar cell such as this and decrease its efficiency. Small dustlike objects probably going very fast that will erode. Our present information on this is relatively optimistic.

NO MASS PRODUCTION AT GODDARD

Senator MARTIN. Your role or function there at the Goddard Space Flight Center is to conduct research and development. Do you do any mass production?

Mr. GOETT. No, we do no mass production. We build prototype models of these pieces of equipment I have shown. As a matter of fact, I don't think there really is as yet any mass production done by anybody in this space business. Most of these are special objects.

Senator MARTIN. You are primarily charged with the development of the various missions that you have listed there?

Mr. GOETT. We cooperate with headquarters in setting up the mission objectives, and then we do as I have said, look at various techniques and approaches whereby these mission objectives can be implemented.

RESULTS PUBLISHED IN NASA REPORTS AND SCIENTIFIC JOURNALS

Senator MARTIN. I have no real firm information about how generally you distribute the knowledge you develop there at Goddard. Do you distribute this generally to the other agencies of the Government or do you make it available to private industry? Are you working in the role our various arsenals did in the military, to sort of guide the industry generally rather than to take over production? I can't quite place you.

Mr. GOETT. We don't take over production at all. The results of either prototype experiments or experiments, such as this on the sounding rockets, that we obtain from any of these satellites which already have been flown, are published in reports which are published both as NASA reports, available to everybody, and also in the scientific journals.

GODDARD SUPPLIES SOME INSTRUMENTATION, CONTRACTS FOR REST

Senator MARTIN. Do you build all the component parts of these?

Mr. GOETT. There is no general answer possible on this. On this one [pointing to Vanguard III], essentially all the component parts were built by Goddard personnel.

On this one [pointing to Pioneer V], our job only was a project management and the Space Technology Laboratory did the major por-

tion of the building. On Project Tiros, which as I say will be launched shortly, the actual instrumentation in that will be built by RCA. We will furnish some additional instrumentation and the tape recorders. RCA will actually build the payload.

Senator MARTIN. On some of these you do the development and building, and on others you do the assembling.

Mr. GOETT. That is right, and on some we just stand by and see that it is done in a manner that we think it should be done.

Senator MARTIN. That is all.

Senator CANNON. Mr. Lehrer?

Mr. LEHRER. You mentioned several times that Tiros would be launched shortly. What do you mean by shortly? Are you referring to a few days or to a number of weeks?

Mr. HORNER. Mr. Lehrer, we hold as confidential the launching dates on all of our space operations that are given more accurately than to the nearest quarter. We would be glad to provide you with that kind of information in closed session. (See note on Tiros on p. 31.)

NASA HOPES FOR GOOD DEFINITION ON PICTURES SENT BACK FROM ORBITING ASTRONOMICAL OBSERVATORY

Mr. LEHRER. You referred to the ultimate development of an orbiting astronomical observatory in order to get the telescope out above the Earth's atmosphere. How will you get usable results back to the Earth? Wouldn't the limited definition of a normal TV picture offset the additional clarity you get by going above the atmosphere?

Mr. GOETT. This is one of the parts of the development. It will be in effect televised back, telemetered back, and we need to develop a system which will give good definition.

Mr. LEHRER. In other words, we still don't know whether it will be feasible to do this?

Mr. GOETT. I think that we know it will be feasible. I think that we already know which particular developments have to be followed in order to do it.

COOPERATION BETWEEN NASA AND DOD ON TRACKING AND DETECTING OF SATELLITES

Mr. LEHRER. Just one final question. You mentioned the two principal minitrack fences, an east-west fence, and a north-south fence. Will you describe just what coordination there is between the operation and placement of these fences and the Department of Defense operation of the satellite detection fences? Do you want to answer that question, Dr. Silverstein?

Dr. SILVERSTEIN. Yes, the minitrack net Mr. Goett has described consists of 14 stations. The net has been modified since the IGY, at which time we had 10 stations, by the addition of 4 stations that are distributed laterally east and west so that we can get readings on satellites that are going on polar orbits. These are a part of the original IGY net expanded to 14 stations. Now the east-west dark satellite net that the Defense Department is operating is for the purpose of surveillance of objects that do not have beacons, but which are what we call dark satellites because they are not radiating. This net

reports into Spacetrack, which is basically operated by the Air Force for the Department of Defense.

At Goddard and at Spacetrack we exchange information on radiating bodies, for example, anything that the Defense Department picks up relative to tracking of our satellite is brought to our attention and we bring to their attention any information we pick up. We have a working relationship with them.

Mr. LEHRER. Dr. Silverstein, were you notified of the so-called dark satellite, and if so, when?

Dr. SILVERSTEIN. Our equipment at our minitrack stations will not pick up dark objects. It is not designed for that. It is designed for picking up radiating objects. And so that we would not have been able to track a dark object in any event.

Mr. LEHRER. I thought you said that you were notified by the Department of Defense on anything they picked up?

Dr. SILVERSTEIN. On radiating bodies, I said.

Mr. LEHRER. That clarifies the matter, Dr. Silverstein.

INSTRUMENTATION MINIATURIZATION MAY LEAD TO LATER PRACTICAL USE

Senator CANNON. Thank you, Doctor.

Mr. Goett, one further question. As a result of your requirements in these payloads, were you able to or did you develop new methods or new instrumentation that would have a practical use in the civilian or industrial field, or on the other hand were you simply refining or using some of their developments to handle your instrumentation?

Mr. GOETT. Actually I think the job that is done is generally a miniaturization job, and miniaturization of existing laboratory type of instrumentation. This is what we really do. Now as to whether this instrumentation will be later of specific use to industry, I would expect or we hope anyway that this Tiros and Nimbus work comes out with a really usable weather prediction type of satellite, and is later used by the Weather Bureau for this purpose.

Senator CANNON. Thank you. Thank you, Mr. Chairman.

GODDARD COMPONENTS, NOW SCATTERED, SOON TO MOVE INTO NEW QUARTERS AT GREENBELT, MD.

Senator STENNIS. Mr. Goett, may I ask you a little more in detail on the matter we discussed here before? You are going to be set up out here in Maryland. Is that in Greenbelt?

Mr. GOETT. Out in Greenbelt.

Senator STENNIS. Yes. Well, where are you operating now?

Mr. GOETT. There is one part of my outfit above a furniture store out in Silver Spring; I am at the naval receiving station over in Anacostia; there is another portion at the Naval Research Laboratory; there is another large portion down at Langley Field; there are a number of them down at Cape Canaveral; and then there are a few down on Pennsylvania Avenue and Seventh Street here.

You probably have seen this, what used to be called the Vanguard computing center. Then there are project managers at a number of the minitrack stations such as Lima, Quito, and the like.

Senator STENNIS. Is your building almost completed?

Mr. GOETT. We have a high priority job to get ready for Project Mercury. We will be moving the first people in to get the communications center used for Project Mercury. We will be moving them in some time between May 1 and May 15.

Senator STENNIS. That is fine.

Mr. GOETT. During the ensuing 6 months most of the people in the Washington area will be moving in there.

Senator STENNIS. That is very fine. I did not realize you were that near. I am sorry I had to miss a few minutes of the latter part of your testimony here, but you adopted a very practical way of bringing these items in here and illustrating by showing us the growth and development item by item you might say of these different vehicles that are quite revealing.

I wish the American people could really know more about them.

Senator Young, we are certainly glad to have you here.

Senator YOUNG. I had difficulty but I am glad to be back.

Senator STENNIS. We have Mr. Goett with us here, who is director of the Goddard laboratories who had given a remarkable demonstration here of these different vehicles and their component parts. Can you think of anything that you would like to ask?

Senator YOUNG. No, I don't now. I am sorry I was detailed on the floor of the Senate.

Senator STENNIS. We have to carry on here in two places.

All right, thank you again, Mr. Goett, for your testimony. We are going to call on Mr. Horner now for some additional facts with reference to the budget. You need not leave but you don't have to stay of course.

STATEMENT OF R. E. HORNER—Resumed

Mr. HORNER. Mr. Chairman, if I may, you will notice that the program directors and the directors of the operating field centers have largely avoided talking about the financial aspects of their programs, and in the interest of completeness, I would like to go over just two or three charts that I have here.

Senator STENNIS. That is exactly what we want you to do. That is in order now and you may proceed.

Mr. HORNER. All right, sir. As in the past, I would like to recommend that page 109 and pages 306 through 308 be entered in the record.

Senator STENNIS. Without objection that will be so ordered.

(The document referred to follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

RESEARCH AND DEVELOPMENT PROGRAMS

Program	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1960 Supplemental	Fiscal Year 1961
AERONAUTICAL AND SPACE RESEARCH:				
Support of NASA plant	$1,097,651	$22,684,000	---	$51,345,000
Research grants and contracts	3,028,000	4,950,000	---	10,000,000
Support of JPL plant	8,156,500 1/	---	---	---
SCIENTIFIC INVESTIGATIONS IN SPACE:				
Sounding rockets	3,556,170	8,811,000	---	8,000,000
Scientific satellites	21,305,114	23,813,000	---	41,700,000
Lunar and planetary exploration	31,882,607	49,000,000	---	45,000,000
Vanguard	21,943,582 1/	---	---	---
SATELLITE APPLICATIONS:				
Meteorology	987,550	7,930,000	---	20,700,000
Communications	3,574,806	3,170,000	---	5,600,000
MANNED SPACE FLIGHT	46,416,333	74,962,000	$12,200,000	107,750,000
VEHICLE SYSTEMS TECHNOLOGY	1,903,651	6,737,000	---	21,200,000
SPACE PROPULSION TECHNOLOGY:				
Solid rockets	615,898	3,785,000	---	2,800,000
Liquid rockets	15,978,589	30,328,000	---	63,000,000
Nuclear systems technology	3,810,496	6,000,000	---	10,000,000
Space power technology	---	4,814,000	---	8,000,000
VEHICLE DEVELOPMENT:				
Scout	6,048,000	2,800,000	---	---
Delta	12,927,417	13,300,000	---	12,500,000
Vega	14,291,494	4,000,000	---	---
Centaur	4,000,000	37,000,000	---	47,000,000
Saturn	---	---	---	134,308,000
TRACKING AND DATA ACQUISITION	3,095,674	16,266,000	---	32,550,000
TOTAL...	$204,619,532	$320,350,000	$12,200,000	$621,452,000

1/ Funded under program activities in 1960 and 1961.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1961 ESTIMATES

SUMMARY OF CONSTRUCTION AND EQUIPMENT PROGRAMS

Program and location	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1960 Supplemental	Fiscal Year 1961
Aeronautical and space research facilities:				
Langley Research Center	$10,850,000	$4,535,000	---	$11,957,000
Ames Research Center	3,720,000	6,305,000	---	980,000
Lewis Research Center	7,800,000	6,660,000	---	9,100,000
Flight Research Center	---	1,850,000	---	---
Space flight development and operations facilities:				
Goddard Space Flight Center	3,867,000	14,070,000	---	9,500,000
Wallops Station	16,193,000	---	---	4,000,000
Jet Propulsion Laboratory	---	7,755,000	---	5,000,000
NASA Huntsville Facility	---	---	---	26,750,000
Atlantic Missile Range	---	740,000	4,000,000	27,750,000
Pacific Missile Range	---	760,000	---	---
Various locations:				
Equipment and instrumentation for:				
Minitrack net	95,000	4,205,000	---	4,750,000
Deep space net	2,550,000	3,500,000	---	8,000,000
Mercury net	2,425,000	28,995,000	6,800,000	15,000,000
Propulsion development facilities	500,000	7,950,000	---	---
Facilities for Rover program	---	1,500,000	---	---
Total	48,000,000	88,825,000	10,800,000	122,787,000
Transferred from Research and Development appropriation	---	-15,000,000	---	---
Appropriated to NACA	23,000,000	---	---	---
Appropriated to NASA	25,000,000	73,825,000	10,800,000	122,787,000
Total appropriations	$48,000,000	$73,825,000	$10,800,000	$122,787,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

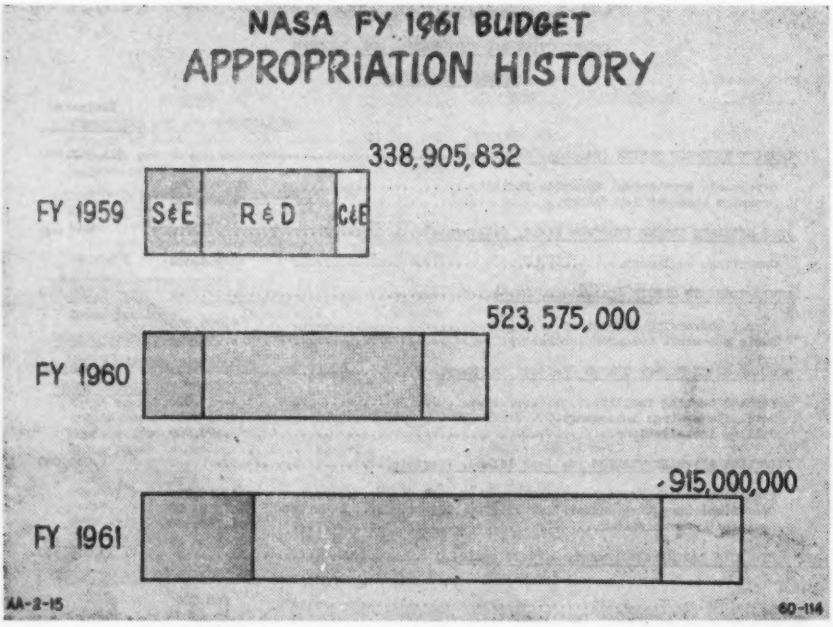
FISCAL YEAR 1961 ESTIMATES

CONSTRUCTION AND EQUIPMENT - 1961 PROGRAM

SUMMARY AND INDEX

		Estimated cost
LANGLEY RESEARCH CENTER (Hampton, Virginia)		$11,957,000
Hypersonic aerothermal dynamics facility	$7,957,000	
Dynamics research laboratory	4,000,000	
AMES RESEARCH CENTER (Moffett Field, California)		980,000
Centrifuge equipment	980,000	
LEWIS RESEARCH CENTER (Cleveland, Ohio)		9,100,000
Energy conversion laboratory	5,050,000	
Basic materials research laboratory	4,050,000	
GODDARD SPACE FLIGHT CENTER (Beltsville, Maryland)		9,500,000
Payload testing facility	3,555,000	
Satellite systems laboratory	4,636,000	
Utility installations	1,309,000	
PILOTLESS AIRCRAFT STATION (Wallops Island, Virginia)		4,000,000
Precision trajectory determination system	1,910,000	
Operations computing center	350,000	
Equipment modernization	1,740,000	
JET PROPULSION LABORATORY (Pasadena, California)		$5,000,000
Plot plan		
Land acquisition	$60,000	
Modernization of laboratory facilities	2,335,300	
Solid propellant facility	1,954,700	
Liquid propellant test cell	500,000	
Antenna range	150,000	
NASA HUNTSVILLE FACILITY (Huntsville, Alabama)		26,750,000
Plot plan		
Saturn static test facility	10,800,000	
Central laboratory and office facility	4,400,000	
Dynamic test facility	600,000	
Pressure test cell	650,000	
Extension to assembly building	2,500,000	
Addition to engineering building	1,137,000	
Completion of guidance and control building	1,948,000	
Addition to fabrication laboratory	215,000	
Addition to checkout building	4,500,000	
ATLANTIC MISSILE RANGE (Cape Canaveral, Florida)		27,750,000
Plot plan		
Completion of Saturn launching complex	2,250,000	
Escape mechanism	300,000	
Hydrogen system	2,500,000	
New Saturn launching complex	21,000,000	
Staging building	1,400,000	
Addition to engineering and laboratory building	300,000	
VARIOUS LOCATIONS		27,750,000
Tracking facilities	27,750,000	
TOTAL PROGRAM		$122,787,000

CHART 62



Mr. HORNER. The first chart which I have here relates to the fiscal history of NASA in the past 2 years, the past year, the present year, and the next year (Chart 62, NASA Fiscal Year 1961 Budget Appropriation History"). In fiscal year 1959 you will notice we had a total of $339 million made available to the NASA operation.

In the current year we have a total of approximately $525 million, and that includes a $23 million supplemental which we have requested and which is currently before the Congress.

EXPLANATION OF NASA'S FISCAL YEAR 1961 BUDGET REQUEST

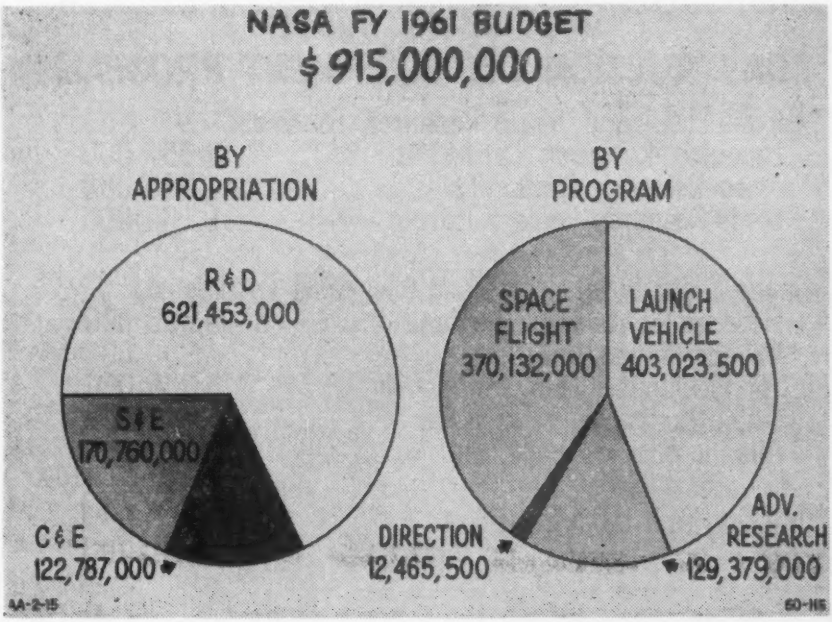
This compares with the $915 million which we are requesting this year. Now I would just like to mention that this rate of growth in our fiscal financial requirements is not simply the result of developing projects in the program, but is also the result of additional responsibilities added to the mission of the NASA in each of the years concerned.

On the next chart (see Chart 63, NASA Fiscal Year 1961 Budget $915,000,000) I show how these budgets are broken down in terms of the pie chart on the left by appropriation, which is the way it will be shown in the backup book, in the research and development account about $621.5 million, in the salaries and expenses accounts $170,760,000 and in the construction and equipment account $122,787,000.

I think it is perhaps more meaningful to invite your attention to the figure on the right, because we have been talking mostly in terms of program orientation here.

The space flight program which was discussed by Dr. Silverstein, Dr. Pickering, and Dr. Goett will require $370,132,000, the launch

CHART 63



vehicle program which is the business of General Ostrander and Dr. von Braun is $403,023,500. The advanced research program which was reviewed for you yesterday by Mr. Abbott is $129,379,000. There is one item here of program direction, about 1½ percent of the entire budget, $12,465,000. This is primarily for the support of the headquarters and certain liaison and coordinating activities throughout the United States.

Now to consider in just a little more detail what is actually involved in the programs, in the next chart I show the salaries and expenses account broken down by laboratory center, showing the staff levels at each of the laboratories and the money required for each (see p. 7).

On the next chart, the construction and equipment is similarly presented (Chart 64, Construction and Equipment Programs).

These are the fund requirements for new construction at each of the centers, and at the bottom, on the bottom line, the tracking and data acquisition requirement is for various locations throughout the world. It is from this account that Dr. Pickering mentioned a few minutes ago there would be $8 million for the deep space net.

Then on the next chart is a breakdown of our research and development account by its various program activities (Chart 65, Research and Development Programs).

Here again the first four and the last are primarily under the cognizance of Dr. Silverstein, Dr. Pickering, and Dr. Goett.

The vehicle system development and space propulsion technology is under the management of General Ostrander and Dr. von Braun.

That concludes the financial review of the program, Mr. Chairman. I will have these charts available for entry in the record if you so desire.

CHART 64

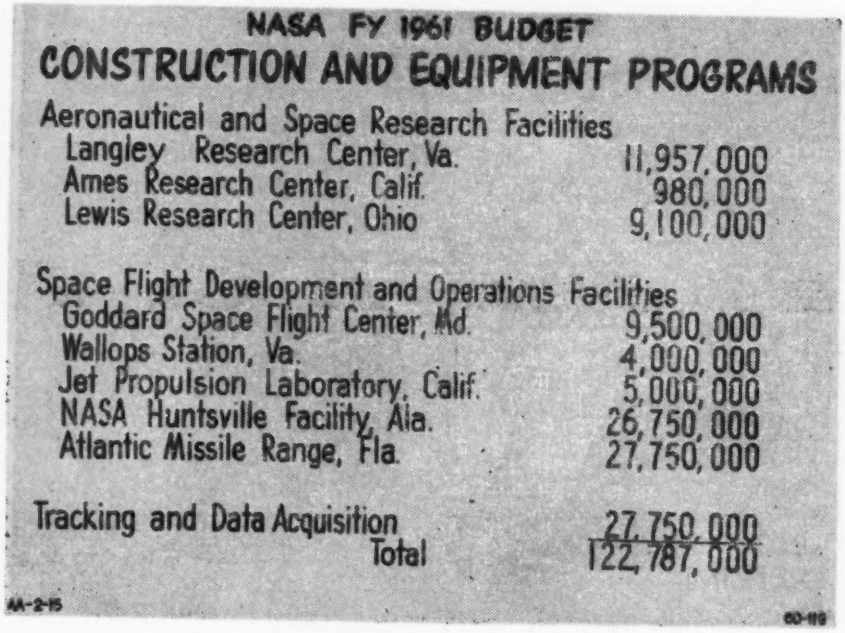
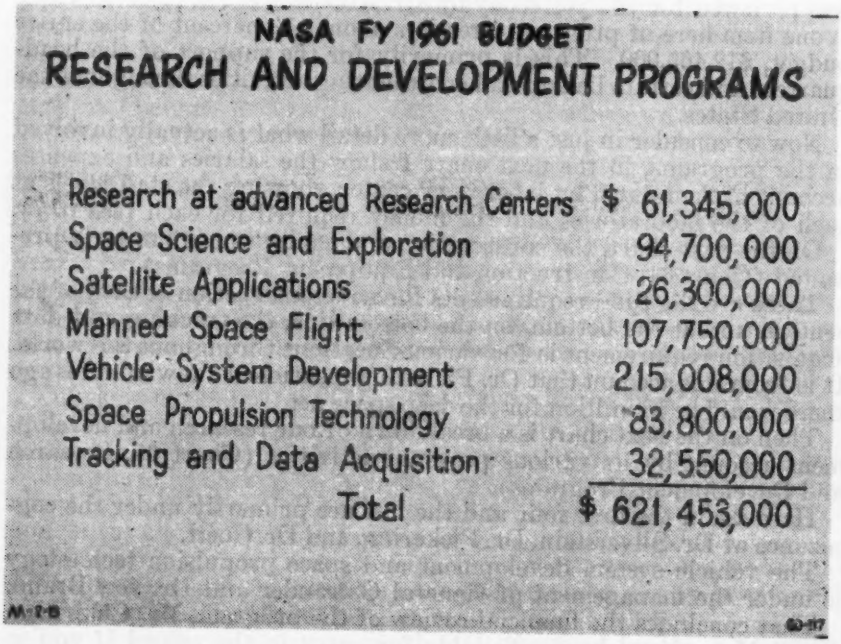

NASA FY 1961 BUDGET
CONSTRUCTION AND EQUIPMENT PROGRAMS
Aeronautical and Space Research Facilities
Langley Research Center, Va. 11,957,000
Ames Research Center, Calif. 980,000
Lewis Research Center, Ohio 9,100,000
Space Flight Development and Operations Facilities
Goddard Space Flight Center, Md. 9,500,000
Wallops Station, Va. 4,000,000
Jet Propulsion Laboratory, Calif. 5,000,000
NASA Huntsville Facility, Ala. 26,750,000
Atlantic Missile Range, Fla. 27,750,000
Tracking and Data Acquisition 27,750,000
Total 122,787,000
AA-2-15
60-119

CHART 65



Senator STENNIS. I wish you would. Without objection the charts will be inserted at their respective places in the record.

Do you have anything further?

Mr. HORNER. I have nothing further, Senator.

NASA HOPES THAT ADDED EXPERIENCE WILL HELP THEM TO MAKE BETTER ESTIMATES ON PROJECT MERCURY COSTS

Senator STENNIS. I have a very brief question or two here for you.

Without going into all the figures, the cost of your Project Mercury—and I am not saying anyone is to blame, but it has been going up, and as I recall has been running considerably over your estimates.

What provision do you have to take care of the possibility that one or more of them or maybe several will run appreciably over the estimates?

Do you have any curb on there to take care of the situation?

Mr. HORNER. There is no curb on this program, Mr. Chairman.

Senator STENNIS. I wasn't suggesting you had it padded, but I mean do you have any allowance?

Mr. HORNER. The only allowance that we have in this program over and above one that we would have had last year, since you made a reference to Project Mercury, is the improvement in our estimates by an additional year's experience. The estimates we have made for this budget are honest, sincere estimates on our part as to what the work we have proposed will cost. We think that we are a little better this year. We think we are substantially better this year than we were last in making our estimates. We have a better feeling for many of our contractor activities, and of course the salaries and expenses and construction equipment we can tie down pretty accurately. I don't have any doubt that we will have unexpected expenses in our research and development accounts. There are some factors that work the other way. We sometimes don't make progress quite as fast as we expect, either, so expenses that we have anticipated to come about in fiscal year 1961, for example, may not actually come about in this until fiscal year 1962. We hope that these two forces will balance each other out and that we will be able to do the work we have suggested for the money we have asked for.

ALLOWANCES FOR OVERTIME SUBSTANTIALLY INCREASED

Senator STENNIS. Specifically did you make any allowances for overtime?

Mr. HORNER. We have made allowances for overtime on our high priority projects to the extent that we are using at the current time.

Senator STENNIS. I know, but you had to get a special dispensation, as I understood this morning, to use your overtime. Have you made any appreciable allowances now for overtime in your high priority projects?

Mr. HORNER. Overtime in this year's budget has been increased substantially. I will have to ask Mr. Ulmer for the exact amount.

Mr. ULMER. In the original NASA budget of $802 million, a total of $5,887,000 was included for overtime, over four times the amount

available in the current year. Under the amended budget of $915 million, the overtime request was increased to $9,087,000.

Mr. HORNER. As I mentioned specifically on our high-priority projects, Project Mercury and the Saturn development, we have allowance for overtime to the extent that the program managers have said they could apply overtime usefully.

In the balance of our program, we have to work on just programing factors and we will provide the committee the data on that.

NASA HAS MADE NO ALLOWANCE FOR INCREASE IN COST OF MATERIALS

Senator STENNIS. Have you made any allowances now for cost increases of materials, and so forth?

Mr. HORNER. We have not, sir; no, sir.

Senator STENNIS. Are there any other items that you have taken into consideration that you recall now in making your estimates?

Mr. HORNER. As I said, Mr. Chairman, the only such allowances that we could claim at all is more realism in our estimates as compared to last year, based on our additional experience.

NASA GETTING AND PAYING FOR MORE SERVICES FROM THE DOD

Senator STENNIS. We heard something that you were going to have to reimburse the Department of Defense this year for some services that have been provided in years before, because the Army ballistic missiles program was working at NACA down at Langley Field in the old days. Don't you have a special project in this budget on that subject?

Mr. HORNER. Our rate of reimbursement to the Department of Defense, Mr. Chairman, is increasing. I think it is accurate to say, every month.

However, the reasons for this increase are all related to the fact that we are getting more services from the Department of Defense.

Now, at one time the NACA, of course, did a lot of research at the request of the Department of Defense without reimbursement for services on either side, and in that process the NACA laboratories did get certain materials and certain assistance from the Department of Defense in carrying out Department of Defense projects. The major change in that particular case is that most of our work now is not in support of the Department of Defense; a larger fraction each year is in support of our own development work. Therefore, we do not get that kind of support in that from the Department of Defense either any more. But this is not a change in policy. It is just a change in balance of the program.

Senator STENNIS. Senator Martin?

Senator MARTIN. No questions.

Senator STENNIS. Senator Young?

Senator YOUNG. I have no questions.

Senator STENNIS. Senator Cannon?

Senator CANNON. No questions.

Senator STENNIS. Mr. Lehrer?

Mr. LEHRER. I believe there are a number of questions, Mr. Chairman, that could well be clarified for the record to complete our story.

MR. HORNER DESCRIBES MODELS TO AUDIENCE

Senator STENNIS. Just before you start, I notice we have some new visitors that have come in. It has been our policy of trying to get more people informed about some of the realities of the space program. Mr. Horner, would you very briefly describe these models, especially with reference to the Pioneer V. I think it is interesting to the public to know that that is an exact duplicate of Pioneer V. You might just take the top off of it a minute and then show those paddle wheels which are used especially for the generation of energy from the sun.

Please explain how that works.

Mr. HORNER. All right, sir. As the chairman has pointed out, this is a model of the Pioneer V satellite that was propelled into an orbit about the Sun during this past month.

The satellite is currently at a distance of about 2.5 million miles from the Earth. It contains a number of scientific experiments in these boxes located around the periphery of the satellite. It was launched on a Thor-Able rocket, which is a Thor first stage with two upper stages that were originally developed in the Vanguard program. The instrumentation and the radio system which returns the data to the United States is powered by batteries which in turn are charged by the action of the sun's rays on these silica cells. The direct conversion of electrical energy is used to charge the batteries which in turn operates the instruments and the radio system. Did you want any more detail than that?

Senator STENNIS. I think that is all right.

Now this large silver one over here, what is that?

Mr. HORNER. The large silver one over here on my left is Vanguard III. It was placed into orbit I believe as of last September. It was one of the successful Vanguard satellites that has a number of scientific experiments to measure different components of radiation in space, magnetic fields with a magnitometer and the tip of the cone, and micrometerites.

THREE COPIES OF EACH PAYLOAD ARE MANUFACTURED

Senator STENNIS. And that is not a model there. That is the actual sister vehicle to the one that went in orbit?

Mr. HORNER. That is correct. I might explain that just a little bit. In the development of these spacecraft and in the continuation of our program, we each time manufacture three models of each spacecraft. The purpose of this is to have one model to test in an environment that is as close to that as the space environment as we can attain, to test it under dynamic conditions of vibration. We have then one model left over which we expect to launch. Then we have an additional copy which is available at launch time if shortly before launch or during countdown we run into difficulties with the spacecraft, some instrument doesn't work, then we can very readily just change the spacecraft to provide a good one.

The reason this is a good, economical thing to do is that most of the money involved in creating these spacecraft is involved in their engineering and design, the actual fabrication is a relatively small part of the investment.

So it is very worthwhile to make an extra model. Then we have a standby spacecraft in case of accident, and we have one that we can substitute in case of minor malfunctions.

Senator STENNIS. I don't think that is generally understood.

Thank you very much, Mr. Horner. All right, Mr. Lehrer.

EXPLANATION OF NASA'S INCREMENTAL FUNDING AND DOD'S FULL FUNDING FOR ATLASES AND THORS

Mr. LEHRER. Mr. Horner, the budget justification book indicates that you plan to order Atlas and Thor vehicles from the Department of Defense on an incremental funding basis. Is this correct?

Mr. HORNER. That is correct; yes, sir.

Mr. LEHRER. On February 1, 1960, the Assistant Secretary of Defense (Comptroller), Mr. Franklin B. Lincoln, testified to the House Appropriations Committee as follows:

> While discussing the strategic missile systems, I would like to point out that the Atlas has now reached a point in its development cycle where it should be, and is being placed on a fully funded basis, in the same manner as any other procurement program. Heretofore, all the Air Force ballistic missiles have been funded on a level of effort basis. The new obligational authority for Atlas in this budget, together with prior year funds, will provide missiles for all 13 squadrons.

Now if the Department of Defense is budgeting for Atlas and Thor missiles on a fully funded basis, how can NASA expect to continue to order these boosters on the basis of partial or incremental funding? Doesn't the Department of Defense have to apply the same rules to its customers as it applies to itself?

Mr. HORNER. Mr. Lehrer, this is primarily the difference between a production program and a research and development program. Ours is very much a research and development program, whereas the ballistic missiles for the Air Force are being produced for the operational inventory. Large numbers of them are being produced in exactly the same configuration.

Now we have discussed this problem with the Department of Defense. The numbers that we are buying in comparison with the numbers that are being bought for the operational inventory in the Department of Defense are so small as to not be a major problem in making the fiscal arrangements within the Department of Defense. They have agreed then to take our orders on a missile or booster start basis, and incremental funding where we pay out on a level of effort basis.

This in some respects works to advantage in the Department of Defense and to ourselves, not only in terms of the rate of application of our financial resources, but it retains a flexibility on the program as to actually which booster will be used for actual space launchings and which boosters will go toward the ballistic missile program.

As you know, there is a much more difficult task, for example, in our program in creating the spacecraft than there is in the creation of the payload for the missile, which is simply a warhead, and is being also produced in quantity.

Therefore, we sometimes have some uncertainties as to exactly when we will want to fire this, and as long as we are paying on a level of effort basis, we can finally take the booster that comes down the production line when we need it, and we can have it modified in accord-

ance with this level of effort to meet our specific needs, because frequently we do have to have special provisions put into the boosters that we are going to use.

DOD ASSURES NASA THAT INCREMENTAL FUNDING WILL BE SATISFACTORY THROUGH NEXT YEAR

Mr. LEHRER. Are you able to assure this committee that there is no prospect of NASA being faced with a Department of Defense request next year for additional funds in order to cover fully the cost of any of the items you buy from them? This is important, since the request before us does not make provision for any such additional funds.

Mr. HORNER. We have been assured by the Department of Defense that our current policies in incremental funding will be satisfactory to them extended through next year.

Mr. LEHRER. Can you tell us for the record who gave you that assurance and when?

Mr. HORNER. I have discussed this primarily with the Under Secretary of the Air Force, who at that time was the Assistant Secretary for Research and Development, Dr. Charyk. I can't say that we have this assurance in writing.

Mr. LEHRER. I believe it would be helpful, Mr. Horner, if you could contact the Department of Defense and get such an assurance in writing so that this committee can be sure that it is providing the funds that are actually and prospectively required for the program laid before us.

Mr. HORNER. I am sure that we can do that.

Mr. LEHRER. So that there can be no question about this, Mr. Horner, will you undertake to provide such a statement for the record?

Mr. HORNER. We will, indeed.

(The letter written by Mr. Horner to the Air Force appears on p. 563. The answer to Mr. Horner's letter is as follows:)

APRIL 11, 1960.

Mr. RICHARD E. HORNER,
Associate Administrator,
National Aeronautics and Space Administration,
Washington, D.C.

DEAR MR. HORNER: This is in reply to your letter of April 1, 1960, addressed to the Under Secretary of the Air Force, which questioned the implications of full financing of the Atlas missile program by the Air Force upon NASA requirements for financing boosters.

The Department of Defense's position, as presented to the Congress, to fully finance the Atlas missile program will not affect NASA's funding for Atlas and Thor boosters.

Fiscal year 1960 and 1961 NASA programs, which you state are based upon an incrementally financed basis, need not be amended to incorporate additional funding for full financing. Booster requirements in fiscal year 1960 and 1961, which your agency has programed, will be handled by the Department of the Air Force on the same basis as in the past.

Sincerely yours,

LYLE S. GARLOCK,
Assistant Secretary of the Air Force.

EXPLANATION OF NEED FOR ADDITIONAL EXCEPTED POSITIONS

Mr. LEHRER. There are two language changes in the pending authorization bill in comparison with the language contained in last

year's bill, and I believe it would be helpful, Mr. Horner, if you could address yourself briefly to each of them. First I refer to section 4 of H.R. 10809, which provides for 30 additional excepted positions, by increasing the total number from 260 to 290, and further providing that 13, rather than 10 of these positions, may be paid salaries of up to $21,000 per year. Would you explain the reason for that?

Mr. HORNER. Yes; the primary reason for needing the additional excepted positions is the growth of our organization, and of course most discreetly related to the assimilation of the Development Operations Division of the Army Ballistic Missile Agency into the NASA. The original Space Act, as you have mentioned, provided us 260 excepted positions, of which 10 could be paid between $19,000 and $21,000. Of those 260, a substantial number have already been filled.

We found in taking on the group under the leadership of Dr. von Braun we could not provide them staff support at the level which is consistent with the rest of our laboratories within the accepted position resources that we were provided.

We have also, as I think somebody has mentioned, earlier, decided to create an Office of Life Sciences in our organization, and that office also required some additional excepted positions.

Now in taking over the Von Braun group, they already had, I believe, 18 supergrade positions in the Department of Defense. These are positions which in some respects are comparable to our excepted positions.

In making the transfer it was agreed at all levels of the executive department that these supergrade positions would be transferred with the agency. However, there were additional excepted position requirements beyond those that we had available.

We did make this a point with the House Authorization Committee, and the language you refer to was written in the bill as a result of that discussion.

Now the increase from 10 to 13 of the positions to be paid at the rate of $19,000 to $21,000 is specifically for one position in our headquarters, which is currently occupied by General Ostrander, which is a position which would ordinarily be paid at that level, and one position for Dr. von Braun as Director of the Marshall Space Flight Center, and one position which we at the current time are proposing to hold in reserve.

TRANSFER OF SUPERGRADE POSITIONS SPECIFICALLY MENTIONED IN TRANSFER PLAN

Mr. LEHRER. Mr. Horner, there seems to be some lack of clarity as to whether the 18 supergrade and Public Law 313 positions which are being transferred from ABMA to NASA will remain part of the authorized number of what we might call above GS–15 salary level positions.

Now at the time that section 203(b)(2) was first passed, we find that the Comptroller General ruled that the existing NACA Public Law 313 positions had to be absorbed within that number. Do you have any specific written assurance from either the Civil Service Commission or the Budget Bureau that the 18 supergrade and Public

Law 313 positions transferred over from ABMA will remain available to NASA, even after this language provision is enacted?

Mr. HORNER. There is no question about it, Mr. Lehrer. There is specific mention of these positions in documentation between ourselves and Department of Defense, and I believe it was specifically mentioned in the plan for the transfer which was provided to the Congress and as you know, lay before the Congress for a period of 60 days. So there is a documentary history both on the legislative and the executive side that these 18 positions will in fact remain with the NASA with the transfer of the agency.

NASA TO HAVE TOTAL OF 308 SUPERGRADE, PUBLIC LAW 313, AND EXCEPTED POSITIONS

Mr. LEHRER. Will you provide for the record at this point a copy of the pertinent documents making this clear, and also a copy of the instructions that have been established within NASA for filling the all excepted positions?

Mr. HORNER. I will be glad to do so. I think you did mention, and I did not give you quite a complete answer, communications with the Civil Service Commission.

We have coordinated our request for the additional positions with the Chairman of the Civil Service Commission and have his endorsement for that request.

Mr. LEHRER. So that the record will be clear, the documentation that you will give us will make it clear that if this provision is enacted into law, NASA will have a total of 308 supergrade, Public Law 313 and excepted positions?

Mr. HORNER. That is correct.

Mr. LEHRER. Eighteen of the former 2 categories and 290 of the latter.

Mr. HORNER. That's right.

(The document referred to follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION EXCEPTED POSITION STATEMENT

NASA has requested 30 additional excepted positions to carry out program needs which have become greater than those which were envisioned when the 260 existing excepted positions were provided in the original Space Act of 1958 (sec. 203b). Three of the 30 would be paid at a rate between $19,000 and $21,000, and these, if added to the existing authority for 10 such jobs, would provide NASA with 13 positions paid in this salary range. All other positions would be within the salary ranges $14,000–$19,000.

This proposal has been cleared with the Bureau of the Budget and the Chairman of the Civil Service Commission (see attached letter from Chairman Roger W. Jones), and is submitted with no objection. It has recently been passed upon favorably by the House of Representatives in its bill H.R. 10809 (sec. 4) authorizing NASA appropriations for fiscal year 1961.

Use of the 260 existing excepted positions has been based on program and staffing plans developed prior to the President's decision to assign to NASA the responsibility for development of boosters of very high thrust. NASA's plan of decentralized operation carries out the detailed research work and development activity in its several field centers. The bulk of the excepted positions has been programed to recognize outstanding individuals in these field installations. Excepted positions have also been used in the NASA headquarters

in order to attract and hold top qualified technical and executive talent. These are required to develop and direct an overall national space program which involves not only the use of the skills in the field centers, but the recources of industry and universities throughout the country.

Individuals selected for excepted positions and their rate of pay are determined on the basis of the scope and complexity of the work, the individual's personal reputation and achievements, and his promise of even further contribution to NASA's mission. The Administrator considers for approval under this special authority only those individuals whose qualifications have been screened and endorsed by an executive salary committee composed of the top leadership in NASA Headquarters. The Deputy Administrator, Dr. Hugh L. Dryden, is the chairman of this committee. Practically all of the positions now at the $16,000 level and above are those of chiefs of major divisions in the research and space flight centers and of chiefs of key professional or technical programs in Headquarters.

Present authority for 260 positions

At the time of the President's decision of October 21, 1959, to transfer the Army's space capability to NASA, practically all of the existing 260 positions had been filled or committed for other aspects of the NASA program. As a result there are only a relatively few positions (actually 20 in all) within the current 260 position authority which can now be made available to meet the new requirements at Huntsville.

As of March 28, NASA has established 222 of the 260 positions and 217 of these are currently filled. There are outstanding five commitments to individuals who will be reporting at a future date for duty with NASA. Of these 222 committed to or filled by individuals, 136 are located in the various field centers and 86 are in key technical and executive positions in the Washington NASA Headquarters. (See attachment A.) The balance of 38 positions, under present plans, will be used as follows:

For positions in existing organization areas of the NASA Washington Headquarters	12
For creation of a new competence in the Life Sciences area (1 other position, the Director of Life Sciences, is filled and therefore included among the 222 established positions	9
For additional technical positions in the new Marshall Space Flight Center at Huntsville	17
Total	38

Transfer of Army GS–17, GS–18 and Public Law 313 positions to NASA

In addition to the 260 positions now available to NASA, there are 18 individuals now with the Van Braun team who will transfer to NASA and who now hold GS–17 or GS–18 positions or Public Law 313 scientific positions. In accordance with the President's transfer plan, which became effective March 14, 1960, these positions are being transferred permanently along with their incumbents from the Department of Defense allocations to the NASA authorization. In short, after July 1, 1960, when the official personnel transfers to NASA take effect, there will be 18 additional positions or a total of 278 for which the rates of pay will be above GS–15. The pertinent documentation covering this transfer of positions is covered in the President's plan (sec. 2b) as follows:

"(b) Without limiting the foregoing provisions of this transfer plan, the functions transferred to the National Aeronautics and Space Administration by the provisons of section 1 of this transfer plan shall include so much of the functions of the Department of Defense, or any officer or organizational entity thereof as relate to the appointment and pay of civilian personnel employed in the Development Operations Division of the Army Ballistic Missile Agency, including authority to continue certain transferred positions in grades 16, 17, and 18 of the general schedule of the Classification Act of 1949, as amended, pursuant to the provisions of section 1 of Public Law 68–377, and authority to continue certain transferred positions requiring the services of specially qualified scientists or professional personnel pursuant to the provisions of section 2 of Public Law 86–377."

This arrangement is further confirmed as one part of the attached letter of March 31, 1960, from Civil Service Commission Chairman Roger W. Jones. (See attachment B.)

Distribution of the proposed 30 additional excepted position

The new requirements which lead to the request for 30 additional excepted positions are as follows:

For top level program responsibilities in the $19,000 to $21,000 range:		
For the Director, Marshall Space Flight Center (Von Braun)	1	
Reserved for civilian replacement, when needed, for the Director of the Office of Launch Vehicle Programs, now held by Donald Ostrander, an Air Force major general on active duty assignment to NASA	1	
Reserved for future program contingencies	1	
Total in $19,000 to $21,000 range		3
For recognition of additional key technical personnel at the Marshall Space Flight Center		15
For additional technical positions at Langley (1), Lewis (2), and Goddard (1)		4
For additional technical positions in headquarters:		
For the Office of Program Planning and Evaluation	1	
For the Office of Advanced Research Programs	1	
For the Office of Launch Vehicle Programs	3	
For the Office of Space Flight Programs	3	
Total additional technical positions in headquarters		8
Grand total		30

The addition of these 30 positions would give NASA a total of 308 positions for which advanced levels of pay above GS–15 may be authorized.

Comparative numbers of excepted positions in the several centers

As indicated under present authority for 260 positions, and detailed in attachment A, there are 136 jobs currently allocated in the various NASA field centers. Three of these are allocated and already filled by the new Marshall Center at Huntsville, and 12 others are assigned to key technical staff in the smaller NASA stations at the Flight Research Center at Edwards, Calif., the Western Operations Office in Los Angeles, the Atlantic Missile Range, and the Wallops (Va.) Station. The remaining field positions (121) are assigned to the four principal NASA centers (Langley, Ames, Lewis, and Goddard) where a total professional staff of 3,155 is employed, or a percentage ratio of 3.8 percent holding excepted positions. It is essential to the working effectiveness and stability of the Von Braun team that NASA seek to provide to its key staff salary recognition which is equal to the rates paid for similar abilities in the other NASA centers.

By comparison with the 3.8 ratio for these centers, the Huntsville staff, with a total of 1,350 professionals, had only 19 GS–17, GS–18, or Public Law 313's under the Department of Defense allocations. Eighteen of these individuals [1] will be transferring to the NASA, or a ratio of 1.3 percent. The percentage is improved, but only to 2.8 percent with the addition of the current remaining balance of 20 excepted slots that have been assigned to the Marshall Space Flight Center. The present request for 30 additional NASA positions is based upon programed requirements for 16 more excepted positions, including the new post at higher pay for the Marshall Center Director, Dr. von Braun. This will provide the new NASA facility with a total of 54 jobs paying above GS–15 (i.e., 18 transferred from the Army, 20 excepted positions made available within the current 260 limitation, and 16 under the requested expansion of authority).

With these 54 positions in hand, the Marshall Center would be able to increase its ratio of excepted jobs to 4 percent of the total professional staff. At the same time, the proposed additions of four jobs to the other centers would result in an average ratio of 3.9 percent in these areas.

In the process of making the above plans, NASA officials have dealt closely with Dr. von Braun to assure that he is familiar with the basis for these proposals. On March 1, 1960, Dr. von Braun advised Dr. Glennan by wire that "a total of 54 positions will help considerably to remedy a situation where we now have only 18 and we understand that this number (54) is sufficient to bring the

[1] The Pershing Missile Project Director currently on Dr. von Braun's staff will remain with the Army until the completion of the Pershing assignment.

proportion of such jobs at Huntsville at least on a par with the other centers. Although this additional allotment will not solve all of our problems in this area, it will certainly help."

Relationship to the Administration's studies of civil service pay proposals

The National Aeronautics and Space Administration in transmitting the request for 30 excepted positions to the Speaker of the House on March 1 was authorized to indicate that "the Bureau of the Budget has advised that there is no objection to the presentation of this proposal for the consideration of the Congress." The Administrator, Dr. Glennan, has kept the Chairman of the Civil Service Commission, Mr. Roger W. Jones, informed of the negotiations leading to this approval. Chairman Jones is advising Senator Stennis by letter (see copy attached) that the proposed legislation is supported by the Civil Service Commission.

ATTACHMENT A

NASA excepted positions—Distribution by location as of Mar. 29, 1960

Rate	Langley	Ames	Lewis	Goddard	Flight research	Marshall	Western office	AMROO	Wallops	Total, field	Total, headquarters	Total, NASA
$21,000											5	5
$20,000	1	1	1	1						4	1	5
$19,000	2	1	1	1						5	18	23
$18,500	1	2	2	2						7		7
$18,000	2		2		1	1				6		6
$17,500	2	4		2			1	1		10	2	12
$17,000	2		2		1					5	3	8
$16,500	4		3	3	1					11	14	25
$16,000	4	3	3	6		1				17	9	26
$15,500	12	8	6	1	1	1		1		30	11	41
$15,000	7	2	11	7	4				1	32	21	53
$14,500				4						4	2	6
$14,000				7						7		7
Total	37	21	31	34	8	3	1	2	1	138	86	224
Transfers			[1] −2							[1] −2		−2
Total			29							136		222

[1] 2 new positions at the headquarters (included in the 86) involve transfers from the Lewis Research Center. Thus, while there are 224 positions currently approved, upon the transfer of these 2 individuals, the total will be reduced by 2.

ATTACHMENT B

MARCH 31, 1960.

Hon. JOHN STENNIS,
Chairman, NASA Authorization Subcommittee,
Senate Committee on Aeronautical and Space Sciences,
U.S. Senate, Washington, D.C.

DEAR SENATOR STENNIS: I am writing you concerning the request to the Congress by the National Aeronautics and Space Administration for an additional 30 excepted positions of which 27 would be paid up to $19,000 and 3 up to $21,000. This request was approved for submission to the Congress by the Bureau of the Budget.

In theory development of salary plans for an improved governmentwide method of salary determination for high level executive and technical positions in the executive branch should avoid both interim and piecemeal approaches. We recognize, however, that urgent needs cannot always await general solutions. In our judgment NASA presents such a case. The administration initially supported an immediate and major exception to existing limitations in order to assure proper leadership for the new national space program. The National Aeronautics and Space Act, as finally enacted, provided 260 excepted positions. NASA's present request for 30 additional excepted positions appears to be a modest and thoroughly defensible extension in view of the President's recent

decisions to enlarge substantially the NASA responsibilities in development of superboosters and to transfer to NASA the Army space team under Dr. von Braun.

An additional 30 NASA excepted positions will not compromise or restrict current efforts to find governmentwide solutions to many problems in the area of salary administration. As a result, we support NASA's request for the proposed legislation under the present circumstances.

In addition to the excepted positions which this legislation would provide, the Civil Service Commission recognizes that there are 18 other positions in the Von Braun organization which will be transferred to NASA, and which are currently compensated as Public Law 313 positions or allocated to GS–17 and 18 within current Department of Defense authorizations. The President in section 2(b) of his transfer plan of January 14, 1960, provided that these positions would be transferred to the NASA for their continued use in carrying out the national space program. After awaiting congressional consideration for 60 days as required by law, this plan became effective March 14, 1960. The Civil Service Commission, therefore, understands that the NASA has taken over the legal authority to use 18 positions which previously were a part of the Department of Defense quotas established under sections 1 and 2 of Public Law 86–377.

Sincerely yours,

ROGER W. JONES,
Chairman, Civil Service Commission.

ADDENDUM TO STATEMENT ON THE NEED FOR 30 ADDITIONAL "EXCEPTED POSITIONS" FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

For the complete information of the committee there are attached 2 lists which provide more detailed information as to (A) how the remaining 38 positions (under the present 260 limit) have been tentatively allocated, and (B) as to how the 30 additional positions requested will be used.

CAUTION.—This information represents the current, but tentative planning, as recommended by the responsible operating officials. Because no specific discussions with or commitments to individuals have been made, premature disclosure of this information, as in the printed record, could have serious effects upon the morale of the key staff at the Marshall and other NASA Centers. Accordingly, at the request of Dr. von Braun and other directors, we ask that their recommendations be considered for the committees' files at this time, and not be published in the hearings or the Congressional Record.

LIST A. PROPOSED USE OF THE 38 POSITIONS REMAINING UNDER THE 260 QUOTA

[Deleted.]

LIST B. PROPOSED USE OF THE 30 ADDITIONAL EXCEPTED POSITIONS CURRENTLY BEING REQUESTED

[Deleted.]

EXPLANATION OF CONTINGENCY ALLOWANCE

Mr. LEHRER. Now will you please discuss briefly the justification for section 1(f) of H.R. 10809, which provides a $20,000 contingency allowance for NASA?

Mr. HORNER. I will be glad to.

We have a requirement in the Administration for small sums of money which the Administrator can use flexibly for unforeseen expenses. I would like to explain this by perhaps a couple of examples. We have a great deal of communication, visiting representation from foreign scientific communities.

We frequently have eminent scientists and Government officials from foreign countries visiting us. During the business day we just feel that it is appropriate to provide food expenses, sometimes travel

expenses within the United States to such visitors. As you can see, this sum is relatively small. We need this sum of money in order to provide reimbursement for those expenses. Not having that at the present time, we have had to do such things as ask for voluntary contributions from members of our own staff to carry out these obligations for foreign visitors where we feel it is necessary.

PROVISION IN APPROPRIATIONS BILL ALLOWS SOME MONEY TO BECOME IMMEDIATELY AVAILABLE

Mr. LEHRER. Earlier today, Dr. von Braun stated that since only 3 months remained in fiscal year 1960, he felt he had enough funds for 1960 with $1.5 million additional that he had been given plus "a minor other adjustment that NASA plans to make" in his 1960 funding. Please tell us what this adjustment is.

Mr. HORNER. I believe Dr. von Braun was referring to his hope that some portion of the fiscal year 1961 funding for the Saturn project might be made available for obligation during fiscal year 1960. A provision in the appropriation language of the fiscal year 1961 appropriation bill to make this possible was requested at the time the $113 million amendment to the 1961 budget was transmitted to the Congress. So, if our 1961 appropriation bill becomes law before June 30, 1960, $20 million of the research and development money and $1 million of the construction and equipment money will become immediately available for obligation.

PROGRAM ADJUSTMENTS FOR FISCAL YEAR 1960

Mr. LEHRER. Will you please provide for the record a table similar to that which we requested last year, showing the reprograming of fiscal year 1960 research and development funds, accompanied by an explanation of the various changes involved.

Use as the base the authorization bill as submitted to, and approved by, this committee and the Congress. Compare this with the revised program that you now have, including the supplemental.

Mr. HORNER. We will be glad to. Would you like to establish a date as that is obviously something that is variable with time.

Mr. LEHRER. As it stands today.

Mr. HORNER. All right.

Mr. LEHRER. Use the latest data that you have available, so that we can indicate what the 1960 program is now and why it differs from that which the members of the committee discussed a year ago.

(The document referred to follows:)

Fiscal year 1960 research and development appropriation program adjustments

Fiscal year 1960 budget request as presented to Senate Committee on Aeronautical and Space Sciences		Allocation of JPL support to appropriate programs	Adjusted program	Fiscal year 1960 budget request in terms of current program titles		Initial allocation of appropriated funds	Fiscal year 1960 supplemental	Current allocation as of Apr. 6, 1960	Reprograming during fiscal year 1960	Reprograming from original submissions
(1)		(1a)	(2)	(3)		(4)	(5)	(6)	(7)	(8)
Support of NASA plant	$16,670,000		$16,670,000	Support of NASA plant	$16,670,000	$22,601,000		$22,732,100	$131,100	$6,062,100
Support of JPL plant	8,156,500	($8,156,500)								
Research contracts	5,200,000		5,200,000	Research grants and contracts	5,200,000	4,950,000		4,971,530	21,530	(228,470)
Sounding rockets	10,000,000		10,000,000	Sounding rockets	10,000,000	8,500,000		9,411,000	911,000	(589,000)
Scientific satellites	22,800,000		22,800,000	Scientific satellites	22,800,000	22,252,000		23,813,000	1,561,000	1,013,000
Lunar probes	7,140,000		7,140,000	Lunar and planetary exploration	14,683,500	17,068,000		42,590,000	25,522,000	27,906,500
Deep space probes	6,803,500	740,000	7,543,500							
Meteorology	10,800,000		10,800,000	Meteorology	10,800,000	7,180,000		7,930,000	750,000	(2,870,000)
Communications	4,700,000		4,700,000	Communications	4,700,000	3,670,000		3,170,000	(500,000)	(1,530,000)
Manned space flight	90,750,000		90,750,000	Manned space flight	90,750,000	90,116,000	$12,200,000	87,120,370	(15,195,630)	(15,829,630)
Space rendezvous techniques	3,000,000		3,000,000							
Advanced vehicle systems	1,500,000	2,330,000	3,830,000	Vehicle systems technology	10,330,000	7,887,000		5,187,000	(2,700,000)	(5,143,000)
Booster recovery systems	1,500,000		1,500,000							
Orbiting space laboratories	2,000,000		2,000,000							
Solid-propellant rockets	3,000,000	1,785,000	4,785,000	Solid rockets	4,785,000	3,785,000		3,785,000	0	(1,000,000)
High-energy propellant rockets	5,000,000	2,987,500	7,987,500	Liquid rockets	38,187,500	30,688,000		29,578,000	(1,110,000)	(8,609,500)
1,000,000-pound thrust single-chamber engine	30,200,000		30,200,000							
Nuclear rocket engines	8,000,000		8,000,000	Nuclear systems technology	8,000,000	6,000,000		6,000,000	0	(2,000,000)
Space engines	3,000,000	314,000	3,314,000	Space power technology	6,314,000	4,814,000		4,814,000	0	(1,500,000)
Auxiliary power units	3,000,000		3,000,000							
Tracking and data acquisition	11,500,000		11,500,000	Supporting activities	11,500,000	18,939,000		16,238,000	(2,701,000)	4,738,000
Scout	2,000,000		2,000,000	Scout	2,000,000	2,000,000		2,800,000	800,000	800,000
Delta	13,300,000		13,300,000	Delta	13,300,000	13,300,000		13,300,000	0	0
Vega	42,800,000		42,800,000	Vega	42,800,000	34,600,000		4,000,000	(30,600,000)	(38,800,000)
Centaur	41,000,000		41,000,000	Centaur	41,000,000	37,000,000		36,250,000	(750,000)	(4,750,000)
				Saturn	0	0		1,500,000	1,500,000	1,500,000
				Vehicle procurement	0	0		7,360,000	7,360,000	7,360,000
Total	353,820,000		353,820,000	Total	353,820,000	335,350,000		332,550,000	(15,000,000)	(33,470,000)

COLUMNAR DESCRIPTION

1. Col. 1 of the table is the fiscal year 1960 program as presented to Congress in the spring of 1960. It includes the fiscal year 1959 supplemental request, since the appropriation act made no distinction between the two requests.

2. Col. 1a and 2 detail the dropping of a single allotment title, "Support of JPL plant." The title was a misnomer since it in fact covered only the supporting research effort at the Jet Propulsion Laboratory. For clearer program definition, then, the programed $8,155,500 was distributed as indicated in accordance with the detailed backup (pp. 227-229) of the fiscal year 1960 congressional submission.

3. Col. 3 shows the same congressional request distributed by revised allotment title. Those allotments that were consolidated are indicated by brackets.

4. Col. 4 lists the initial program-by-program allocation based upon the action of the final appropriation bill, Public Law 86-213. The net difference between cols. 3 and 4 is $18,470,000, the amount of the budget cut.

5. Col. 5 shows the approved fiscal year 1960 supplemental appropriation, all of which is applied to Project MERCURY in the manned space flight program.

6. Col. 6 is the current allotment breakdown; it includes the fiscal year 1960 supplemental.

7. Col. 7 is derived by subtracting col. 6 from the sum of cols. 4 and 5. It indicates the net reprograming activity by program since the initial allocation. The net appropriation difference is $15 million, representing a transfer of that amount from Project MERCURY R. & D. to Project MERCURY C. & E.

8. Col. 8 is derived by subtracting the current allocations (col. 6) from the whole program presented to Congress (cols. 3 and 5). The net appropriation difference, $33,470,000, is the sum of the budget cut of $18,470,000 and the appropriation transfer of $15,000,000.

Fiscal Year 1960 Program Change Analysis

1. Support of NASA plant

(*a*) Col. 7: $111,000 was required for unprogramed transportation costs at Wallops station, and $20,100 was transferred to the Flight Research Center to reimburse that activity for drop test materials consumed in connection with Project MERCURY.

(*b*) Col. 8: Certain program items—i.e., transportation of R. & D. objects, nonadministrative communications—were transferred from S. & E. to R. & D. funding with congressional approval; this necessitated an allotment increase.

2. Research grants and contracts

(*a*) Col. 7: $21,530 represents the transfer of obligations incurred under the manned space flight program for university research in the area of biosciences; these advanced studies are more rightfully carried on under the "Directorate of advanced research" than under that of "Space flight programs."

(*b*) Col. 8: The residual difference of the initial decrease of $250,000.

3. Sounding rockets

(*a*) Col. 7: $600,000 is the cost of the nuclear emulsion recovery vehicle contract overrun with GE; $311,000 was reprogramed to allow greater university participation in the upper atmosphere sounding program.

(*b*) Col. 8: The residual difference of the initial $1,500,000 decrease.

4. Scientific satellites

(*a*) Col. 7: $1,000,000 was reprogramed to begin work on the long-leadtime aspects of the geophysical observatory satellites; $561,000 was reprogramed to cover the increased cost estimates of satellites and instruments under construction at GSFC and at universities.

(*b*) Col. 8: The residual difference of the initial decrease of $548,000.

5. Lunar and planetary exploration

(*a*) Col. 7: PIONEER V incurred an overrun of $1,550,000; $634,000 programed for the launching of ATLAS 20-D in manned space flight, was transferred when that vehicle was made available for a second attempt at a lunar orbiter mission because of the overwhelming success of the BIG JOE shot; $14,922,000 of former VEGA commitments to JPL were reprogramed to begin the AGENA, CENTAUR, and SATURN lunar and planetary payload effort; $10,000,000 was reprogramed to initiate two further lunar orbiter missions; reductions of $1,584,000 were made by postponing program elements until fiscal year 1961.

(*b*) Col. 8: The initial increase in program estimates of $2,384,500 was based on a planned increased lunar payload effort already begun in fiscal year 1959.

6. Meteorology

(*a*) Col. 7: $750,000 was reprogramed to fund cost overruns on TIROS I.

(*b*) Col. 8: The initial reduction of $3,620,000 assumed a stretchout of the meteorological satellite program.

7. Communications

(*a*) Col. 7: A reduction of $500,000 in the advanced studies area was required to fund more urgent lunar navigation, lunar soft landing, and manned controlled landing studies.

(*b*) Col. 8: The initial reduction of $1,030,000 envisaged a postponement of advanced studies and development.

8. Manned space flight

(*a*) Col. 7: $15,000,000 was transferred to the MERCURY range C. & E. account to cover immediate contractual requirements, $21,530. $20,100 and $34,000 were transferred as noted in paragraphs 1(*a*). 2(*a*). and 5(*a*); $120,000 was transferred to cover increased costs of computations for MERCURY. $100,000 was programed for the manned controlled landing study noted in par. 7(a), and $500,000 was made available from the VEGA cancellation for cost increases.

(*b*) Col. 8: The residual difference from the initial reduction of $634,000.

9. Vehicle systems technology

(*a*) Col. 7: $500,000 was transferred to cover Scout overruns; $760,000 was transferred as indicated in par. 6(*a*); $1,550,000 was transferred as indicated in par. 4(*a*). $400,000 was reprogramed for the studies noted in par. 7(*a*), and $700,000 was reprogramed from overestimates of GSFC computation costs.

(*b*) Col. 8: The net effect of the initial $2,443,000 reduction and of subsequent reprogramings has been to sharply curtail and postpone orbiting laboratory and space rendezvous developments. Booster recovery work is now part of the MERCURY REDSTONE and the SATURN programs.

10. Solid rockets

(*a*) Col. 8: The initial reduction to accommodate the reduced fund availability.

11. Liquid rockets

(*a*) Col. 7: $300,000 was transferred for Scout support, $60,000 for propellent utilization valve work, and $750,000 to cover part of the Presidentially directed overtime authorization for SATURN.

(*b*) Col. 8: Of the initial reduction of $7,499,500, $6,000,000 was applied to the F-1 engine and the rest to other liquid rocket advanced development.

12. Nuclear systems technology

(*a*) Col. 8: The initial reduction to accommodate the reduced fund availability.

13. Space Power technology

(*a*) Col. 8: The initial reduction to accommodate the reduced fund availability.

14. Supporting activities

(*a*) Col. 7: Increases of $120,000 (par. 8(*a*)) and of $32,000 (for additional field engineering) were offset by transfers of $31,000 for Wallops station transportation costs, $700,000 for overestimates of computer costs, and $2,122,000 of the former VEGA-required commitments at JPL (pars. 1(*a*), 9(*a*), and 5(*a*)).

(*b*) Col. 8: The initial increase of $7,439,000 was dictated by new data reduction expenses and the requirement to fund items formerly carried under the S. & E. appropriation (see par. 1(*b*)).

15. SCOUT

(*a*) Cols. 7 and 8: Cost overruns on the 1st vehicles are estimated at $800,000.

16. DELTA

(*a*) No changes.

17. VEGA

(*a*) Cols. 7 and 8: VEGA program was canceled Dec. 11, 1959. $4,000,000 is currently reserved against termination costs, but some of this is expected to be recoverable.

18. CENTAUR

(*a*) Col. 7: $750,000 was transferred to fund the SATURN program (see par. 11(*a*)).

(*b*) Col. 8: The initial reduction of $4,000,000 was based on cancellation of the advanced studies originally programed.

19. SATURN

(*a*) Cols. 7 and 8: See pars. 11(*a*) and 18(*a*).

20. Vehicle procurement

(*a*) Cols. 7 and 8: A new allotment established to isolate the costs of the AGENA vehicles. Funding source was VEGA unobligated funds at the time of cancellation.

DISCUSSION OF WIND TUNNEL ACTIVITIES AND COORDINATION

Mr. LEHRER. Would you discuss briefly the question of coordination of wind tunnel activities, first within NASA and then between NASA and the Department of Defense? I raise this matter because a few months ago, the chairman of the subcommittee, visited the Arnold Engineering Development Center, and the question arose, which was never quite answered, as to how their wind tunnel facilities and capabilities are put to use and how NASA's are related.

Mr. HORNER. I would like to try the explanation on a little different tack if I might. Wind tunnels are instruments of research and they are instruments of development.

It is not possible really to coordinate the use of wind tunnels as an end in themselves because the real coordination has to come in the programs which are going to be carried out in wind tunnels. Now we have a very significant aerodynamic test, research test, research experimentation program in the NASA, in our own program.

That program is formulated of course with full knowledge of what our wind tunnel capabilities are. The research program in itself does not absorb the full capacity of even all of the wind tunnels under the jurisdiction of NASA and there are many that are not under the jurisdiction of NASA. Most of the other wind tunnels in the Nation, with minor exceptions, are used in either applied research or development tasks. Now these tasks are coordinated. When a development contractor has a requirement for wind tunnel work, his first determination is one of deciding what test conditions he needs.

He then surveys the wind tunnels that are available and decides which tunnels can provide those test conditions. He will then go to that particular tunnel and try to get time in it. If that schedule happens to be full and he can't get in that particular tunnel, then he will try to get into the next one that is closest to it. This I think is the only practical way to coordinate the use of wind tunnels. It results on some occasions in having wind tunnels unemployed. Because of the very great volume of aerodynamic research that has been accomplished in this country in the past 20 years, we find ourselves today with wind tunnels that are not fully utilized, and some wind tunnels that are not utilized at all, that we have actually put tunnels in mothballs and are holding them in reserve in case their specific characteristics might be used in the future.

There are other wind tunnels under other jurisdictions that are also in the same circumstance.

Mr. LEHRER. We have observed, however, in visiting some of the key manufacturers, that almost all of them have projects for building new wind tunnels capable of handling high mach numbers. Many of these are indirectly paid for by the Department of Defense in its procurement contracts. Is there any mechanism for coordinating the construction of additional wind tunnels, so that we don't have unnecessary building, since it is the taxpayer who pays for it, either directly or indirectly?

Mr. HORNER. In this respect I can speak better from my past experience than I can from my current experience, because we certainly had a great deal of this problem in the Air Force.

as noted in paragraphs 1(a), 2(a), and 5(a); $120,000 was transferred to cover increased costs of computations for MERCURY. $100,000 was programed for the manned controlled landing study noted in par. 7(a), and $500,000 was made available from the VEGA cancellation for cost increases.
(b) Col. 8: The residual difference from the initial reduction of $634,000.

80. *Vehicle procurement*
(a) Cols. 7 and 8: A new allotment established to isolate the costs of the AGENA vehicles. Funding source was VEGA unobligated funds at the time of cancellation.

The first mechanism that is available of course is to deny any contract support for these wind tunnels. Incidentally, all contractors support their need—their individual need for a wind tunnel on the basis of having it immediately available in their own backyard where their own scientists and engineers can have immediate access to the data, and there is some justification for this.

But the Government as a whole can rarely justify building a tunnel simply for the purpose of saving a contract or the difficulty of going across town or across the State even.

Now, contractors, of course, have means of building wind tunnels even if the Government does not directly support it; as you have indicated. There are some means of getting indirect support in that from the Government. One means, of course, is by rapid tax amortization. The Department of Defense even came to the point in recent years of denying rapid tax amortization consideration for these, and I think this is probably the best mechanism for control of construction of new facilities. I do not personally know of any new facilities that are under construction or even under planning either in industry or in Government today that duplicates present capability. There are new facilities planned and under construction, but they are extensions of present capabilities.

Mr. ABBOTT. I would like to say first that I concur wholeheartedly in everything Mr. Horner has said. He has pointed out the major processes of coordination. However, there are certain existing formal processes and I think it might be worth while to mention them. Where these development testing chores go between the Department of Defense and the NASA, these requests for wind tunnel time go to what are called project allocation and priority groups. There are two such groups—one for aircraft and missiles and another group for propulsion. Each has one member from each of the three military services and one member from NASA. So there is coordination at that level, but I would like to say again that this occurs only after the technical coordination has been carried out by the working people.

There are some other formal or semiformal procedures that affect the whole wind tunnel picture too. For instance, with regard to new construction, each year we do discuss rather informally with the Department of Defense our budgetary requests—the ones we think we are going to make for the following year—and the Department of Defense discusses theirs with ours, so that there is an exchange of information which frequently results in changes because neither of us want to duplicate what the other is doing.

Also, there are periodically carried out jointly between the Department of Defense and the NASA rather complete surveys of what wind tunnels are available in the country, the current workloads and what workloads are foreseen for the future.

This is done as the need for such a survey becomes apparent, and just yesterday members of my staff sat with members of Mr. York's staff in the Pentagon to make arrangements for initiating another such survey at this time.

So that there really is pretty good coordination.

DEVELOPMENT BY THE AIR FORCE OF 2 MILLION POUND THRUST SOLID FUEL BOOSTER

Mr. LEHRER. There has been public discussion of the Air Force proceeding with development of a solid booster which would have growth potential to 2 million pounds of thrust. Are you familiar with this and is this an impingement upon NASA's role of handling all heavy boosters?

Mr. HORNER. We are familiar with it. As a matter of fact, we have received communication from the Department of the Air Force inviting our participation in the management of the program. Prior to the actual implementation of the program we had discussions with the Department of Defense. This in effect is one of the many areas where we have common development needs with the Department of Defense. We find it impossible to do everything in our program, and I am sure they find it impossible to do everything in their program.

In the interests of avoiding unnecessary duplication, we usually sit down over these kinds of problems and decide which agency is going to provide the resources, sort of be the program initiator. And in almost all cases to date we have come to the conclusion that we would jointly participate in the management of the program so that we have full information on both sides, and we are looking forward to the possibility of getting useful information and possibly a useful line of development out of this particular feasibility development that the Department of the Air Force is undertaking.

CHANGES IN NASA'S HIGH ENERGY PROPELLANT PROGRAM

Mr. LEHRER. Last year, this committee restored to the authorization bill $4,750,000 to cover the cost of a new proposed new facility for high energy propellants. This was later dropped from the NASA program. Could you tell us what is being done to fill this void?

Mr. HORNER. There have been several things happened that have influenced that particular situation. Some of them quite recent.

We, as you know, were forced into some reprograming last year, and this was one of the items that fell out of our program list of things to be done immediately during that reprograming cycle, with the idea that it would be delayed.

Now since that time we have, as a result of continuous study, finalized on the configurations for the upper stages of Saturn and more or less put our money on liquid hydrogen and liquid oxygen, for which there are facilities and there is work going forward. We have acquired, through transfer, the facilities and personnel of the development operations division, which will become the Marshall Space Flight Center, and there are facilities and skills available in that organization, and we have reviewed again with the Air Force the overall national needs, and recognize that there is quite an extensive capability in this respect at the rocket engine test station at Edwards, which we are jointly using with the Air Force, and we have now come to the conclusion that it would not be desirable to build a new facility.

Mr. LEHRER. But do you intend to continue work on fluorine, as a fuel for rockets?

Mr. HORNER. We have research work continuing in this area and we undoubtedly will continue to the point of making a decision that, yes, we will go ahead or no, we have exploited all there is and don't find it useful. Fluorine, as you know, has some real advantages and some real disadvantages, and we have not come to the point of committing ourselves to a development that would require an additional facility.

LIST OF NASA'S RESEARCH AND DEVELOPMENT CONTRACTS

Mr. LEHRER. There has been testimony to the fact that, as the years go by, NASA expects to spend a larger proportion of its money on outside contracts with industry, with nonprofit institutions and universities. Could you tell us how much of your work is now being done by nonprofit research institutions and by universities?

If you don't have that readily available, please provide this information for the record, plus a listing of all research and development contracts that have been awarded this fiscal year, indicating those which have gone to universities, nonprofit institutions, and to private individuals or private companies.

Mr. HORNER. I will be glad to provide that for the record. Our total ratio of out-of-house work to inhouse work measured by our dollar investments is just about 3 to 1. I think the statement was made that the out-of-house ratio would increase on the basis that our organization has been formed in rather large lumps. We have taken on big groups of people. We do not at the moment anticipate any further substantial growth in staff, and therefore as the program grows, the ratio of work that is done out of house by contract will grow in parallel.

(The information is as follows:)

The following is a list of all research and development contracts in excess of $50,000 awarded by the National Aeronautics and Space Administration since its inception. Contracts marked with an asterisk (*) are private companies. All others are universities, nonprofit institutions, or Government agencies.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA Headquarters

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAM
Support of NASA plant

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 110,000 OBLIGATIONS	1959 ALLOTMENT: $ 110,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ 1,618,000 OBLIGATIONS	1960 ALLOTMENT: $ 1,618,000 PENDING COMMITMENTS
NASW-6 (HS-417)	Motion picture describing project Echo	JPL (California Tech)	---	---	.06	---
HS-554	Management Survey	McKinnsey Co.	---	---	---	.06
Miscellaneous Contracts (Under $50,000)			.09	---	.68	.06
TOTAL			.09	---	.74	.06

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Research grants and contracts

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,889,345 OBLIGATIONS	1959 ALLOTMENT: $ 2,889,345 PENDING COMMITMENTS	1960 ALLOTMENT: $ 4,971,530 OBLIGATIONS	1960 ALLOTMENT: $ 4,971,530 PENDING COMMITMENTS
NsG 1-59 (HS-52)	Molecular study	Yale University	.11	---	---	---
NsG 5-59 (HS-87)	Investigations of forces between atoms, molecules, and ions	University of Maryland	.06	---	---	---
NsG 34-59 (HS-88)	Research associateship program	National Academy of Sciences	.35	---	---	---
NsG 3-59 (HS-90)	Studies of performance and flow in test section of maximum Mach number wind tunnels	The Rice Institute	.11	---	---	---
NsG 14-59 (HS-111)	Synthesis of high-order non-linear control systems	Rensselaer Polytechnic Institute	.08	---	---	---
NsG 8-59 (HS-121)	Determination of solar parallax	Yale University	.11	---	---	---
NsG 4-59 (HS-122)	Investigations of radar methods of exploring moon and planets	University of Michigan	.13	---	---	---
NsG 10-59 (HS-125)	Reaction kinetics of accelerating flames	University of California	.12	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 409 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Research grants and contracts

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,889,345 OBLIGATIONS	1959 ALLOTMENT: $ 2,889,345 PENDING COMMITMENTS	1960 ALLOTMENT: $ 4,971,530 OBLIGATIONS	1960 ALLOTMENT: $ 4,971,530 PENDING COMMITMENTS
NsG 6-59 (HS-139) (HS-526)	Research in solid state physics	Rice Institute	.50	---	---	.30
NsG 16-59 (HS-153)	Study of General instability of cylindrical shells	University of Florida	.06	---	---	---
NsG 17-59 (HS-159)	General instability in stiffened circular cylinders	New York University	.12	---	---	---
NsG 28-59 (HS-235)	Research on automatic control theory	Purdue University	.20	---	---	---
NsG 29-60 (HS-222)	Satellite and planetary motion	Yale University	.15	---	---	---
NsG 31-60 (HS-223)	Unstable aerodynamic flow and noise	Massachusetts Institute	.07	---	---	---
NsG 36-60 (HS-253)	Research on hybrid numerical circuitry	Case Institute of Technology	.18	---	---	---
NASW-96 (HS-372)	Research study of implications of the use of space for peaceful and scientific purposes	Brookings Institution	---	---	.10	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Research grants and contracts

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,889,345 OBLIGATIONS	1959 ALLOTMENT: $ 2,889,345 PENDING COMMITMENTS	1960 ALLOTMENT: $ 4,971,530 OBLIGATIONS	1960 ALLOTMENT: $ 4,971,530 PENDING COMMITMENTS
NsG 18-59 (HS-158)	Study of cylindrical and conical shells	California Institute of Technology	.11	---	---	---
NsG 50-60 (HS-397)	Study of ionization phenomena by high velocity molecular beams	Colorado Seminary (University of Denver)	---	---	.12	---
NsG 48-60 (HS-399)	Research on microwave gaseous electronics	Rensselaer Polytechnic Institute	.04	---	.01	---
NsG 52-60 (HS-433)	Research for convection heat transfer in annular passages	Stanford University	---	---	.07	---
NsG 57-60 (HS-449)	Geochemical research on tektites, stony meteorites and radioation damage in related silicate materials	Mellon Institute	---	---	.10	---
NsG 60-60 (HS-486)	Investigation of flow and fracture of high strength materials	Catholic University of America	---	---	.06	---
HS-491	Research on interplanetary gas and dust	University of Maryland	---	---	---	.10
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Research grants and contracts

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $2,889,345 OBLIGATIONS	1959 ALLOTMENT: $2,889,345 PENDING COMMITMENTS	1960 ALLOTMENT: $4,971,530 OBLIGATIONS	1960 ALLOTMENT: $4,971,530 PENDING COMMITMENTS
NsG 38-60 (HS-313)	Continuation of research on dispersion-strengthened materials	Rensselaer Polytechnic Institute	---	---	.06	---
NTF-64 (HS-314)	Research on boundary layer transition	Bureau of Standards (Commerce)	---	---	.07	---
NsG 39-60 (HS-315)	Research on cavitation erosion phenomena	University of Michigan	---	---	.09	---
NsG 40-60 (HS-322)	Research on rarified gas flows	California Institute of Technology	---	---	.12	---
NsG 43-60 (HS-352)	Research on celestial mechanics	University of Cincinnati	---	---	.18	---
HS-307	Research on long range economic, social, political and international aspects of space activities	Rand Corporation	---	---	---	.02
NsG 44-60 (HS-355)	Parameters affecting detonation in gaseous mixtures	Ohio State University	---	---	.11	---
NTF-45 (HS-138)	Assist Space Science Board	Nat'l Science Foundation	.11	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Research grants and contracts

1959 ALLOTMENT: $ 2,889,345

1960 ALLOTMENT: $4,971,530

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NS-493	Research on condensation with condensate removal by centrifugal force	North Carolina State	---	---	---	.07
NS-528	Research in negative ion formation in gases	University of Florida	---	---	---	.06
NS-539	Investigation of phyco-physiology in controlled environments	University of Maryland	---	---	---	.22
NS-547	Investigation of polarization of non-thermal radiation from Jupiter	Yale University	---	---	---	.08
NS-551	Research on atomic and molecular collision cross-sections and atomic frequency standards	Yale University	---	---	---	.22
NS-553	Biochemical study of mixed cultural prototypes in a closed ecological system	Mississippi State University	---	---	---	.05
NS-555	Research on protection against acceleration by immersion during hypothermia Suspended Animation	University of Cincinnati	---	---	---	.07
Miscellaneous Contracts (Under $50,000)			.28	---	.23	.39
TOTAL			2.89	---	1.32	1.58

NASA FORM NO. 400 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Support of JPL plant

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 8,156,500 OBLIGATIONS	1959 ALLOTMENT: $ 8,156,500 PENDING COMMITMENTS	1960 ALLOTMENT: $ ----- OBLIGATIONS	1960 ALLOTMENT: $ ----- PENDING COMMITMENTS
NASW-6 (HS-41) (HS-323)	Conduct of research (see also (Lunar and planetary exploration", "Communications", "Vehicle systems technology", "Liquid Rockets", "Vega", and "Supporting Activities".)	JPL (California Tech)	8.16	---	---	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			8.16	---	---	---

NASA FORM NO. 459 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Sounding Rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 123,734 OBLIGATIONS	1959 ALLOTMENT: $ 123,734 PENDING COMMITMENTS	1960 ALLOTMENT: $ 504,956 OBLIGATIONS	1960 ALLOTMENT: $ 504,956 PENDING COMMITMENTS
NASW-31 (HS-68)	Instrument two Aerobee-Hi rockets for Neutron intensity measurements	New York University	.10	---	---	---
NsG 51-60 (HS-382)	Increase scope of NsG 7-59 for design and construction of equipment for an ultraviolet sky survey (see also "Scientific Satellites")	Smithsonian Astrophysical Laboratory	---	---	.10	---
NASW-4 (HS-464)	Extend contract NASW-4 ($175,000 S & E 1959) for rocket instrumentation	University of Michigan	---	---	---	.20
NTF-99 (HS-483)	Sounding rocket studies of the ionosphere	Ordnance (Army)	---	---	.09	---
HS-484	Sounding rocket studies of the ionosphere in collabration with NTF-99	University of Michigan	---	---	---	.12
Miscellaneous Contracts (Under $50,000)			.02	---	---	---
TOTAL			.12	---	.19	.32

NASA FORM NO. 469 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 950,014 OBLIGATIONS	1959 ALLOTMENT: $ 950,014 PENDING COMMITMENTS	1960 ALLOTMENT: $ 906,906 OBLIGATIONS	1960 ALLOTMENT: $ 906,906 PENDING COMMITMENTS
NASW-17 (ES-51)	Reduction analysis (see also "Lunar and planetary explorations")	Iowa State University	.02	---	---	---
NASW-33 (ES-73) (ES-504)	Improvement of frequency standards	Massachusetts Institute of Technology	.05	---	---	.07
NASW-56 (ES-112)	Construction of radiation detection instruments	University of Minnesota	.07	---	---	---
NASW-37 (ES-131) (ES-460)	Gamma ray detection instruments and prototype for one satellite vehicle	Massachusetts Institute of Technology	.07	---	.23	---
NsG 7-59 (ES-137)	Scientific and engineering study for instrumenting an orbiting telescope	Smithsonian Institute	.10	---	---	---
NASW-54 (ES-141)	Instrumentation measuring intensity radio noise levels above ionosphere	University of Michigan	.08	---	---	---
NASW-55 (ES-142)	Instrumentation measurement ultraviolet solar emission spectrum	University of Michigan	.08	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 486 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS
MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 950,014 OBLIGATIONS	1959 ALLOTMENT: $ 950,014 PENDING COMMITMENTS	1960 ALLOTMENT: $ 906,906 OBLIGATIONS	1960 ALLOTMENT: $ 906,906 PENDING COMMITMENTS
NASW-59 (HS-147)	Design and build directional counter system to investigate primary cosmic radiation	University of North Carolina	.06	---	---	---
NoG 24-59 (HS-190) (HS-529)	Study for determining the physical properties of the ionosphere	University of Illinois	.07	---	.01	---
NASW-66 (HS-196)	Design studies for a multicolor ultraviolet telescope system	University of Wisconsin	.06	---	---	---
NoG 30-60 (HS-229)	Expend program for determining physical properties of ionosphere	Stanford University	.09	---	---	---
NASW-107 (HS-329)	Research on solid state photo detectors	University of Rochester	---	---	.12	---
NASW-89 (HS-271)	Study of solar ultraviolet radiation from both rockets and satellites	University of Colorado	.11	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 950,014 OBLIGATIONS	1959 ALLOTMENT: $ 950,014 PENDING COMMITMENTS	1960 ALLOTMENT: $ 906,906 OBLIGATIONS	1960 ALLOTMENT: $ 906,906 PENDING COMMITMENTS
NsG 51-60 (HS-382) (HS-556)	Increase scope of NsG 7-59 for design and construction of equipment for an ultra-violet sky survey (See also "Sounding Rockets")	Smithsonian Institution	---	---	.10	.12
HS-513	Abstract space sciences literature	American Meteorological Society	---	---	---	.05
HS-520	Processing data obtained from Able III & Explorer VI	Stanford University	---	---	---	.12
Miscellaneous Contracts (Under $50,000)			.09	---	.01	.05
TOTAL			.95	---	.47	.41

NASA FORM NO. 499 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Lunar and planetary explorations

1959 ALLOTMENT: $ 7,404,140

1960 ALLOTMENT: $ 21,998,217

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NASW-81 (HS-171)	Lunar seismograph system	California Tech.	.13	---	---	---
NASW-6 (HS-41) (HS-412) (HS-309)	Deep-space study	JPL (California Tech.)	1.30	---	21.66	---
NASW-6 (HS-129 & HS-201)	Vega-space vehicle and related payloads (see also "Vega")	JPL (California Tech.)	5.00	---	---	---
NTF-71 (HS-40)	Construction of addition to building No. 125 at JPL	Corps of Engineers (Army)	.14	.01	---	---
NASW-17 (HS-51)	Space probe instrumentation (see also "Scientific satellites")	Iowa State University	.29	---	---	---
NASW-24 (HS-53)	Cosmic ray instrument	University of Chicago	.30	---	---	---
NASW-82 (HS-180)	Lunar seismograph system	Lamont Geological Observatory (Columbia University)	.12	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 409 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Lunar and planetary explorations

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 7,404,140 OBLIGATIONS	1959 ALLOTMENT: $ 7,404,140 PENDING COMMITMENTS	1960 ALLOTMENT: $ 21,998,217 OBLIGATIONS	1960 ALLOTMENT: $ 21,998,217 PENDING COMMITMENTS
NASW-75 (HS-212)	Design, test, and construct prototype to measure plasma density and energy	Massachusetts Institute of Technology	.10	---	---	---
NsG 37-60 (HS-312)	Preparation of a basic lunar map	University of Chicago	---	---	.07	---
HS-427	Instrumentation to measure atmospheric pressure between earth and moon	University of Michigan	---	---	---	.05
NsG 56-60 (HS-450)	Studies of lunar surface characteristics and development at advanced measurements techniques	California Institute of Technology	---	---	.12	---
HS-512	Research on properties of lunar surface using thermal photographic techniques	Harvard University	---	---	---	.10
Miscellaneous Contracts (Under $50,000)			.01	---	---	---
TOTAL			7.39	.01	21.85	.15

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS
MONTH AND YEAR: February, 1960

PROGRAM: SATELLITE APPLICATIONS: Communications

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 130,000 OBLIGATIONS	1959 ALLOTMENT: $ 130,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ 1,070,000 OBLIGATIONS	1960 ALLOTMENT: $ 1,070,000 PENDING COMMITMENTS
NASW-6 (HS-177)	Transmitter for the passive communications satellite program	JPL (California Tech.)	.13	---	---	---
NASW-6 (HS-328)	Conversion equipment JPL antenna	JPL (California Tech.)	---	---	.07	---
NASW-6 (HS-340) (HS-412)	Purchase of items for the launching of communications satellite in March 1960	JPL (California Tech.)	---	---	1.00	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			.13	---	1.07	---

NASA FORM NO. 469 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 90,000 OBLIGATIONS	1959 ALLOTMENT: $ 90,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ --- OBLIGATIONS	1960 ALLOTMENT: $ --- PENDING COMMITMENTS
NASW-70 (HS-173)	Develop prototype of a photo-synthetic gas exchange	University of Minnesota	.06	---	---	---
Miscellaneous Contracts (Under $50,000)			.03	---	---	---
TOTAL			.09	---	---	---

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE SYSTEMS TECHNOLOGY

1959 ALLOTMENT: $ 593,651

1960 ALLOTMENT: $ 3,847,349

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NASW-6 (HS-323-411-412)	Conduct of research (see also "Support of JPL plant")	JPL (California Tech.)	.59	---	3.80	---
NASW-130 (HS-432)	Study operation of an interplanetary vehicle	Massachusetts Institute of Technology	---	---	.05	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			.59	---	3.85	---

NASA FORM NO. 460 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 469 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Solid rockets

1959 ALLOTMENT: $ ----

1960 ALLOTMENT: $ 2,055,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NASW-6 (HS-412)	Conduct of research (see also "Support of JPL plant")	JPL (California Tech.)	---	---	2.06	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			---	---	2.06	---

NASA FORM NO. 469 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Liquid rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,000,000 OBLIGATIONS	1959 ALLOTMENT: $ 2,000,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ 2,988,000 OBLIGATIONS	1960 ALLOTMENT: $ 2,988,000 PENDING COMMITMENTS
NASW-6 (RS-58) (RS-412)	Conduct of research (see also "Support of JPL plant")	JPL (California Tech.)	2.00	---	2.99	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			2.00	---	2.99	---

NASA FORM NO. 480 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

TOTAL						

NASA FORM NO. 400 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Space power technology

1959 ALLOTMENT: $ ----

1960 ALLOTMENT: $ 1,064,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NASW-6 (HS-412)	Conduct of research (see also "Support of JPL plant")	JPL (California Tech.)	---	---	1.06	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			---	---	1.06	---

NASA FORM NO. 400 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT: Vega

1959 ALLOTMENT: $ 3,000,000

1960 ALLOTMENT: $ 2,400,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: OBLIGATIONS	1959 ALLOTMENT: PENDING COMMITMENTS	1960 ALLOTMENT: OBLIGATIONS	1960 ALLOTMENT: PENDING COMMITMENTS
NASW-6 (HS-129) (HS-309) (HS-412)	Vega space-vehicle and related payloads	JPL (California Tech.)	3.00	---	2.40	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			3.00	---	2.40	---

NASA FORM NO. 468 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NASA FORM NO. 489 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: SUPPORTING ACTIVITIES

1959 ALLOTMENT: $ 304,604

1960 ALLOTMENT: $ 2,332,817

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: OBLIGATIONS	1959 ALLOTMENT: PENDING COMMITMENTS	1960 ALLOTMENT: OBLIGATIONS	1960 ALLOTMENT: PENDING COMMITMENTS
NASW-6 (HS-135) (HS-412)	R&D on improved tracking and receiving equipment	JPL (California Tech.)	.30	---	2.28	---
NsG 35-60 (HS-311)	Continuation of volunteer photographic and radio tracking program	Society of Photographic Scientists & Engineers	---	---	.05	---
Miscellaneous Contracts (Under $50,000)			.01	---	---	---
TOTAL			.31	---	2.33	---

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: NASA HEADQUARTERS

MONTH AND YEAR: February, 1960

PROGRAM: ANTICIPATED REIMBURSEMENTS

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ --- OBLIGATIONS	1959 ALLOTMENT: $ --- PENDING COMMITMENTS	1960 ALLOTMENT: $ 1,000,000 OBLIGATIONS	1960 ALLOTMENT: $ 1,000,000 PENDING COMMITMENTS
HS-490	Amend NASW-6 for testing solid propellant rockets for ARPA Order No. 107-60 10/19/59	JPL (California Tech.)	---	---	---	.35
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			---	---	---	.35

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 469 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Support of NASA Plant

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 614,300 OBLIGATIONS	1959 ALLOTMENT: $ 614,300 PENDING COMMITMENTS	1960 ALLOTMENT: $5,274,100 OBLIGATIONS	1960 ALLOTMENT: $5,274,100 PENDING COMMITMENTS
NAl-3679	Modify impact basin	Endebrock-White Co. *	.06	---	---	---
NAS1-218	Modify T-29 airplane	Butler Aviation *	.15	---	---	---
NAS1-366	Maintenance of lawns	Greenbrier Farms, Inc. *	---	---	.03	.07
L-67,714(G)	Gasoline and oil	836th Air Base Group	---	---	.04	.01
L-70,937	Fuel oil	Reese Oil Corp. *	---	---	.08	.09
NAl-3200	Sensor and support equip't.	Northrop Aircraft Inc. *	---	---	.26	---
NAS1-473	Energy storage capacitors	Westinghouse Electric Corp.*	---	---	.11	---
96-15	Electrostatic generator	Unknown	---	---	---	.09
NAS1-510	Repairs to rotor	McGraw-Edison Co. *	---	---	.08	---
NAl-3420	Spherical rocket motors	Thikol Chemical Corp. *	---	---	.11	---
NAS1-608	Two(2) offset presses	Unknown	---	---	.05	---
99-161	Loading apparatus	Unknown	---	---	---	.08
9y-16	Three airframes	Unknown	---	---	---	.06
Miscellaneous Contracts (Under $50,000)			.40	---	2.79	1.33
TOTAL			.61	---	3.55	1.73

NASA FORM NO. 469 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SATELLITE APPLICATIONS
Communications

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 932,000 OBLIGATIONS	1959 ALLOTMENT: $ 932,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ 700,000 OBLIGATIONS	1960 ALLOTMENT: $ 700,000 PENDING COMMITMENTS
NAl-3411	Nine(9) 100 foot ballons	General Mills, Inc. *	.06	---	---	---
NAS5-53	Aerojet junior rocket motors	Aerojet General Corp. *	.15	---	---	---
LRO-833	3 sets booster hardware	Unknown	---	---	---	.12
LRO-801	3 sets hardware	Unknown	---	---	---	.11
Miscellaneous Contracts (Under $50,000)			.37	.20	.03	.08
TOTAL			.58	.20	.03	.31

NASA FORM NO. 488 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 488 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,367,781 OBLIGATIONS	1959 ALLOTMENT: $ 2,367,781 PENDING COMMITMENTS	1960 ALLOTMENT: $ 2,571,000 OBLIGATIONS	1960 ALLOTMENT: $ 2,571,000 PENDING COMMITMENTS
NA85-57	Destruct system, design of transport vehicles and launcher and one (1) control study, (Little Joe)	North American Aviation *	1.33	---	---	---
NAS1-204	Consulting services, (Project Mercury)	Aeronutronic Systems, Inc.*	.09	.01	---	---
NAS1-416	Control systems, (Little Joe)	Minneapolis-Honeywell Regulator Co. *	.08	---	---	---
L-55,931G	Castor development	Dept. of Army, Ordnance Corp.	---	---	.27	---
L-74,110G	Services at Bermuda, (Project Mercury)	Federal Aviation Agency	---	---	.16	---
L-75,090G	Services at Honolulu and Canton Island, (Project Mercury)	Federal Aviation Agency	---	---	.09	---
L-75,693G	Transportation equipment, (Project Mercury)	General Services Administration	---	---	.05	---
L-75,876G	Services at Kauai, Hawaii, (Project Mercury)	Navy Department, Bureau of Naval Weapons	---	---	.23	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 488 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT (Continued)

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $2,367,781 OBLIGATIONS	1959 ALLOTMENT: $2,367,781 PENDING COMMITMENTS	1960 ALLOTMENT: $2,571,000 OBLIGATIONS	1960 ALLOTMENT: $2,571,000 PENDING COMMITMENTS
LRO-773	Port to port transportation Charges, (Project Mercury)	Western Electric Co. *	---	---	---	.25
LRO-815	Operational materials for trucking and ground instrumentation system, (Project Mercury)	Unknown	---	---	---	.23
Miscellaneous Contracts (Under $50,000)			.74	.03	.01	---
TOTAL			2.24	.04	.81	.48

NASA FORM NO. 450 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

TOTAL						

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT
Scout

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,116,000 OBLIGATIONS	1959 ALLOTMENT: $ 2,116,000 PENDING COMMITMENTS	1960 ALLOTMENT: $1,431,500 OBLIGATIONS	1960 ALLOTMENT: $1,431,500 PENDING COMMITMENTS
NAS1-168	161,000 lbs. ammonium perchlorate	American Potash and Chemical Corp. *	.05	---	---	---
NAS1-249	Scout IV vehicles and launcher	Chance Vought Aircraft, Inc.*	1.04	---	.07	---
NAS5-61	Second-stage reaction control system	Minneapolis-Honeywell Regulator Co. *	.16	---	.01	---
NAS5-53	Fabrication and static firing of Jupiter rockets	Aerojet General Corp. *	.15	---	.15	.14
NAS1-336	Subcarrier oscillators	Vector Mfg. Co., Inc. *	.06	---	---	---
NAS1-328	Command receivers	Motorola, Inc.*	.06	---	---	---
NAS1-483	Radar beacons	Avion Div., A.C.V. Ind., Inc.*	.05	---	---	---
S-10000	Rocket motors	Bureau of Ordnance	.06	---	---	---
L-55,931G	Castor rocket	Dept. of Army, Ordnance Corp.	---	---	.21	---
LRO-600	Services, in-flight tests	Unknown	---	---	---	.32
S-10106	X-254 motors	Dept. of Navy, Bureau of Ordnance	---	---	.31	---
LRO-613	Changes on Airframe	Chance Vought Aircraft, Inc.*	---	---	---	.07
Miscellaneous Contracts (Under $50,000)			.40	.06	---	.01
TOTAL			2.03	.06	.75	.54

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SUPPORTING ACTIVITIES

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $560,000 OBLIGATIONS	1959 ALLOTMENT: $560,000 PENDING COMMITMENTS	1960 ALLOTMENT: $1,500,000 OBLIGATIONS	1960 ALLOTMENT: $1,500,000 PENDING COMMITMENTS
NAS1-239	Consulting services, (Project Mercury)	R.C.A. Services Co. *	.09	---	---	---
NAS1-229	Consulting services, (Project Mercury	Massachusetts Institute of Technology	.40	---	1.09	---
LRO-766	Communication services, Canary Islands, and London Terminal, (Project Mercury)	1.Transradio Espanola 2.Compania Telefonica Nacional de Espana 3.Overseas Cable and Wireless, Ltd., London *	---	---	---	.22
Miscellaneous Contracts (Under $50,000)			.05	---	---	---
TOTAL			.54	---	1.09	.22

NASA FORM NO. 440 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

TOTAL			.54	---	1.09	.22

NASA FORM NO. 409 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT: Anticipated Reimbursements - Project Mercury

1959 ALLOTMENT: $ ---

1960 ALLOTMENT: $582,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
LRO-834	Test Communication and diesel generators	Western Electric Co. *	---	---	---	.23
LRO-858	Radars and test equipment	Western Electric Co. *	---	---	---	.35
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			---	---	---	.58

NASA FORM NO. 409 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT
Anticipated Reimbursements - Scout

			1959 ALLOTMENT: $ ---		1960 ALLOTMENT: $5,060,000	
CONTRACT NO.	PURPOSE	CONTRACTOR	OBLIGATIONS	PENDING COMMITMENTS	OBLIGATIONS	PENDING COMMITMENTS
L-55,931G	Jet vane tests	Bureau of Ordnance, Dept. of Army	---	---	.03	---
L-77,203G	10 Rocket Motors	U.S. Army Missile Command	---	---	.49	---
L-72,505G	19 Rocket Motors	Bureau of Ordnance, Dept. of Navy	---	---	.36	.12
NAS5-53	Fabrication, delivery and testing of algol rocket motors	Aerojet General Corp.*	---	---	.38	.43
NAS5-61	Study and fabrication of standard scout guidance and control system	Minneapolis-Honeywell Regulator Co. *	---	---	.25	.37
NAS1-457 and NAS1-553	Fabrication of airframe structure of scout vehicle	Chance Vought Aircraft, Inc*	---	---	.64	.91
LRO-645	Changes in motor models	Bureau of Ordnance, Dept. of Navy	---	---	---	.03
LRO-684	Test and checkout equipment	Minneapolis-Honeywell Regulator Co. *	---	---	---	.09
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

TOTAL				

NASA FORM NO. 488 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LANGLEY RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT
Anticipated Reimbursements - Scout (Continued)

1959 ALLOTMENT: $ ---

1960 ALLOTMENT: $ 5,060,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
LRO-685	Alteration of 2 (two) guidance and control systems	Minneapolis- Honeywell Regulator Co.*	---	---	---	.08
LRO-885	5 Guidance control systems	Minneapolis- Honeywell Regulator Co.*	---	---	---	.85
Miscellaneous Contracts (Under $50,000)			---	---	---	---
TOTAL			---	---	2.15	2.88

NASA FORM NO. 488 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: AMES RESEARCH CENTER

MONTH AND YEAR: February 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS
Support of NASA Plant

1959 ALLOTMENT: $ ---

1960 ALLOTMENT: $ 3,637,000

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT OBLIGATIONS	1959 ALLOTMENT PENDING COMMITMENTS	1960 ALLOTMENT OBLIGATIONS	1960 ALLOTMENT PENDING COMMITMENTS
NAS2-242	Continuous writing framing camera	Beckman and Whitley, Inc.*			.09	
60-3005	Ion accelerator	Unknown			---	.16
60-3247	Air Density measuring instr.	Vidya Inc. *			---	.06
60-3061	S/M to repaint unitary structure	Unknown			---	.05
	Miscellaneous Contracts (Under $50,000)				1.50	.60
	TOTAL				1.59	.87

NASA FORM NO. 450 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

					1.59	.87
TOTAL						

NASA FORM NO. 409 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LEWIS RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS
Support of NASA plant

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $187,700 OBLIGATIONS	1959 ALLOTMENT: $187,700 PENDING COMMITMENTS	1960 ALLOTMENT: $6,256,000 OBLIGATIONS	1960 ALLOTMENT: $6,256,000 PENDING COMMITMENTS
NAS3-541	Liquid Nitrogen (bulk)	Linde Company *	---	---	.05	---
NAS3-680	Magnetic Tape Recording System	Ampex Corporation *	---	---	.07	---
	Multi Phase Liquid Metal Turbind Rig		---	---	---	.10
	Miscellaneous Contracts (Under $50,000)		.19	---	3.62	.75
	TOTAL		.19	---	3.74	.85

NASA FORM NO. 409 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LEWIS RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $956,157 OBLIGATIONS	1959 ALLOTMENT: $956,157 PENDING COMMITMENTS	1960 ALLOTMENT: $217,000 OBLIGATIONS	1960 ALLOTMENT: $217,000 PENDING COMMITMENTS
NAS3-305	Furnishing Six Automatic Flight Control Systems	Minneapolis-Honeywell *	.15	---	---	---
NAS3-335	Furnishing two Telemetering Systems for Prototype Man-for-Space Capsule	Electro Mechanical Research, Inc. *	.12	---	.06	---
NAS3-343	Furnishing five, 3-channel Miniature airbourne tape recorders	Cook Electric Co. *	.08	---	---	---
NAS3-350	Furnishing two Telemetry and Beacon Antenna Systems	General Electric Co. *	.06	---	.01	---
NAS3-369	Furnishing Radar Tracking Beacons and Engineering Services	Aero Geo. Astro Corp. *	.05	---	---	---
Miscellaneous Contracts (Under $50,000)			.49	---	.10	---
TOTAL			.95	---	.17	---

NASA FORM NO. 449 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

TOTAL	.95	---	.17	---

NASA FORM NO. 409 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: LEWIS RESEARCH CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Liquid rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,065,000 OBLIGATIONS	1959 ALLOTMENT: $ 2,065,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ --- OBLIGATIONS	1960 ALLOTMENT: $ --- PENDING COMMITMENTS
NAS3-262	Propellant tank assemblies	Douglas Aircraft Co. *	.11	---	---	---
NAS3-234	Furnishing six Rocket Thrust chambers and necessary tooling	Solar Aircraft Co.*	.33	---	---	---
NAS3-354	3600 Gallon liquid Hydrogen trailer	Herrick L. Johnson, Inc. *	.05	---	---	---
	Services and materials to Pulse Weld Two Rocket Thrust Chambers		---	.06	---	---
Miscellaneous Contracts (Under $50,000)			1.37	.05	---	---
TOTAL			1.86	.11	---	---

NASA FORM NO. 409 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: FLIGHT RESEARCH CENTER

MONTH AND YEAR: February , 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS
Support of NASA Plant

1959 ALLOTMENT: $ 35,651

1960 ALLOTMENT: $ 900,700

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NAS 4-15	Communication Services X-15				.07	.03
Miscellaneous Contracts (Under $50,000)			.03	---	.54	---
TOTAL			.03	---	.61	.03

NASA FORM NO. 488 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

	TOTAL		.05		.02	.05

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: AERONAUTICAL AND SPACE RESEARCH: Support of NASA Plant

1959 ALLOTMENT: $ 150,000

1960 ALLOTMENT: $ 4,187,300

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
S-1845(G)	Alteration, Hanger		---	---	.07	---
GS-1	For services in connection with the tenancy of elements of GSFC at NRL	NRL (ONR-Navy)	---	---	2.50	---
S-2019	For services, time and material to accomplish shop work orders	Naval Weapons Plant	---	---	.33	---
GS-141	Purchase of FM/FM Ground Station		---	---	---	.08
	Miscellaneous Contracts (Under $50,000)		.15	---	.37	.14
	TOTAL		.15	---	3.27	.22

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: AERONAUTICAL AND SPACE RESEARCH: Research Grants and Contracts

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 138,655 OBLIGATIONS	1959 ALLOTMENT: $ 138,655 PENDING COMMITMENTS	1960 ALLOTMENT: $ --- OBLIGATIONS	1960 ALLOTMENT: $ --- PENDING COMMITMENTS
NASW-74* (HS-204)	Develop techniques for fabrication of refractory coated metals	T. R. Finn and Co. *	.10	---	---	---
Miscellaneous Contracts (Under $50,000)			.04	---	---	---
TOTAL			.14	---	---	---

NASA FORM NO. 449 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

	TOTAL		.14	---	---	---

NASA FORM NO. 499 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS			REPORTING INSTALLATION GODDARD SPACE FLIGHT CENTER MONTH AND YEAR February, 1960			
PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Sounding Rockets			1959 ALLOTMENT: $ 3,432,436		1960 ALLOTMENT: $ 8,306,044	
CONTRACT NO.	PURPOSE	CONTRACTOR	OBLIGATIONS	PENDING COMMITMENTS	OBLIGATIONS	PENDING COMMITMENTS
NASW-69* (HS-26-207)	20 ASPAN rockets	Cooper Development Co.*	.14	---	---	---
HS-26* (HS-154) (HS-207)	20 Nike ASP boosters	Ordnance (Army)	.05	---	---	---
NASW-25* (HS-43)	Develop instrumentation (see also "Scientific satellites")	Itek Corporation *	.16	---	---	---
NASW-58* (HS-71)	12 Javelin rockets (ARGO D-4)	Aerolab Development Co. Ordnance (Army)	.24	---	---	---
NASW-36* (HS-156) (HS-25-27-28)	5 Aerobee-Jr. vehicles 5 Aerobee-Hi vehicles 7 Spaerobee kits	Aerojet General Corp. *	.66	---	---	---
NTF-2* (HS-71)	12 X-248A6 rockets	Ordnance (Navy)	.14	---	---	---
NTF-3* (HS-71)	12 Honest John 24 Nike rockets	Ordnance (Army)	.16	---	---	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Sounding rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $3,432,436 OBLIGATIONS	1959 ALLOTMENT: $3,432,436 PENDING COMMITMENTS	1960 ALLOTMENT: $8,306,044 OBLIGATIONS	1960 ALLOTMENT: $8,306,044 PENDING COMMITMENTS
HS-474*	Study of winds, diffusion and expansion of gases in the upper atmosphere	Geophysics Corporation of America *	---	---	---	.26
HS-47	Partial support of Space Sciences Division (Townsend) (see also "Scientific Satellites")	NRL (ONR - Navy)	1.84	---	---	---
GS-1	Research & Development Services in connection with the tenancy of elements of the GSFC at NRL	NRL (ONR - Navy)	---	---	4.15	---
GS-22 NAS 5-14	Vacuum calibration system, and for obtaining a working prototype of a new low pressure detector	National Research Corp. *	---	---	.11	---
GS-33	Procure 25 Aerobee 150-A two stage rocket vehicles, 25 camera extensions and 15 nose extensions		---	---	---	.75
NAS 5-225 GS-134	Procure 9 Solar Beam Experiment rocket instrumentation systems	Cook Research Lab., Div.*	---	---	.23	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Sounding Rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 3,432,436 OBLIGATIONS	1959 ALLOTMENT: $ 3,432,436 PENDING COMMITMENTS	1960 ALLOTMENT: $ 8,306,044 OBLIGATIONS	1960 ALLOTMENT: $ 8,306,044 PENDING COMMITMENTS
GS-41	Multi-channel pulse height analyzer for satellite and space probe use		---	---	---	.15
NAS 5-202 GS-58	Development of aluminum cased Nike-Asp sounding rocket vehicle	Cooper Dev. Corp. *	---	---	.33	---
GS-86	Amendment to GS-58 increased Scope		---	---	---	.07
GS-93	Procure motors required for four Argo D-8 Vehicles, one Argo D-8 Sounding Rocket Vehicle, Vehicle Hardware, Analyses, reports, liaison, etc.		---	---	---	.58
GS-115	Procure attitude control system		---	---	---	.25
GS-125	Procure Skylark Rockets		---	---	---	.15
GS-130	Procure Rocket engine and Ignitor		---	---	---	.10
GS-190		New Mexico State Univ.	---	---	---	.07
Miscellaneous Contracts (Under $50,000)			.03	---	.14	.16
TOTAL			3.42	---	4.96	2.54

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific Satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 20,325,100 OBLIGATIONS	1959 ALLOTMENT: $ 20,325,100 PENDING COMMITMENTS	1960 ALLOTMENT: $22,756,904 OBLIGATIONS	1960 ALLOTMENT: $22,756,904 PENDING COMMITMENTS
NASW-25* (HS-43-430)	Develop instrumentation including "Model Atmosphere Studies" (See also "Sounding Rockets")	Itek Corporation *	.45	---	---	---
NIF-33 (HS-48)	Research on rubidium frequency standards	Bureau of Standards (Commerce)	.27	---	---	---
NASW-62* (HS-148)	Design and construction ammonia beam maser and associated dividing circuitry	Hughes Aircraft Co. *	.20	---	---	---
NIF-52* (HS-175)	R&D in specified areas (see also "Lunar and planetary explorations" and "Vehicle systems technology")	ABMA (Army)	.10	---	---	---
NIF-53* (HS-178)	Radio beacons for satellite	AOMC (Army)	.56	---	.22	---
NASW-98* (HS-226)	Electron density by Langmuir technique	Geophysical Corp. of America *	.11	---	---	---
NIF-11* (HS-234)	Astronautical detectors .05 to 120A	NRL (ONR)	.10	---	---	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contracts for NASA Hdqtrs. TOTAL						

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 400 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific Satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $20,325,100 OBLIGATIONS	1959 ALLOTMENT: $20,325,100 PENDING COMMITMENTS	1960 ALLOTMENT: $22,756,904 OBLIGATIONS	1960 ALLOTMENT: $22,756,904 PENDING COMMITMENTS
NIF-12* (HS-1) (HS-46-304-325-332-357-392-426) (HS-515)	Radiation payload for Juno 11, 19a (see also "Lunar and planetary explorations"	AOMC (Army)	.15	---	1.71	---
NIF-17* (HS-6-194-361-409)	1 earth satellite (including 1 Thor-Able booster and 1 Thor to be used in "Delta" program) (see also "Lunar and planetary exploration")	BMD (ARDC-Air Force)	7.12	---	2.23	---
NIF-61* (HS-21-301-333-404)	5 Juno II boosters	AOMC (Army)	8.54	---	5.06	---
NIF-29* (HS-37)	Computing services (60%) (see also "Lunar and planetary explorations")	Bureau of Standards (Commerce)	.08	---	---	---
NASW-20* (HS-42)	Alterations to buildings 5-7 Bellevue Annex	Alton Engineering Co. *	.14	---	---	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 400 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE
Scientific Satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 20,325,100 OBLIGATIONS	1959 ALLOTMENT: $ 20,325,100 PENDING COMMITMENTS	1960 ALLOTMENT: $22,756,904 OBLIGATIONS	1960 ALLOTMENT: $22,756,904 PENDING COMMITMENTS
NASW-113* (HS-273)	Study of satellite-borne solar pointing control	Ball Brothers Research Corporation *	.25	---	---	---
NTF-15* (HS-4) (HS-305)	Continuation of inflatable sphere program	AOMC (Army)	---	---	.10	---
NTF-80* (HS-374) (HS-501)	Initiate work on gamma ray astronomy satellite	AOMC (Army)	---	---	.62	---
NTF-81* (HS-375) (HS-498)	Initiate work on ionosphere measurements satellite	AOMC (Army)	---	---	.59	---
NTF-83* (HS-390)	Determine physical properties of the ionosphere	Bureau of Standards (Commerce)	---	---	.13	---
NTF-84* (HS-389)	Provide tables of electronic densities vs. altitude	Bureau of Standards (Commerce)	---	---	.10	---
NASW-45* (HS-403)	Study of chemical physics of planetary atmospheres	Geophysical Corp. of America *	---	---	---	.15
NTF-89* (HS-434)	Equipment and supplies for temporary recording stations for Explorer VII	U. S. Weather Bureau (Commerce)	---	---	.05	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific Satellites

1959 ALLOTMENT: $20,325,100

1960 ALLOTMENT: $22,756,904

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 OBLIGATIONS	1959 PENDING COMMITMENTS	1960 OBLIGATIONS	1960 PENDING COMMITMENTS
NS-438*	Study of charged particles and fields in space	Rand Corporation	---	---	---	.11
NTF-90* (NS-414)	Develop television system	ONR (Navy)	---	---	.11	---
NS-468*	Measurement and analysis of data for Explorer satellites	ABMA (Army)	---	---	.08	---
NS-517*		Martin Company *	---	---	---	.15
NS-47	Partial support of Space Sciences Division (Townsend) (see also "Sounding Rockets")	NRL (ONR - Navy)	2.00	---	---	---
GS-1	Research & Development Services in connection with the tenancy of elements of the GSFC at NRL	NRL (ONR - Navy)	---	---	3.42	---
S-2056	Furnish services of 2 mechanic engineers, 2 engineering draftsman, and 2 engineering technicians to work in Mech. Systems Branch	Naval Weapons Plant	---	---	.06	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contracts for NASA Hdqtrs. TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Scientific Satellites

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $20,325,100 OBLIGATIONS	1959 ALLOTMENT: $20,325,100 PENDING COMMITMENTS	1960 ALLOTMENT: $22,756,904 OBLIGATIONS	1960 ALLOTMENT: $22,756,904 PENDING COMMITMENTS
GS-137	Procure Satellite Borne Solar Pointing Control		---	---	---	.84
GS-140	Expand and extend the Nonr-2982(00) (X) Contract		---	---	---	.07
NIF-40* (HS-120)	Reimbursement for special activities	AOMC (Army)	.10	---	---	---
GS-133	Development of a Geodetic Satellite		---	---	---	.50
GS-205	Procure two sensor vector component magnetometer		---	---	---	.06
Miscellaneous Contracts (Under $50,000)			.15	---	.20	.17
*Indicates contract for NASA Hdqtrs.		TOTAL	20.32	---	14.68	2.05

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIAGTIONS IN SPACE
Lunar and planetary explorations

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 24,478,467 OBLIGATIONS	1959 ALLOTMENT: $ 24,478,467 PENDING COMMITMENTS	1960 ALLOTMENT: $ 28,551,783 OBLIGATIONS	1960 ALLOTMENT: $ 28,551,783 PENDING COMMITMENTS
NTF-4* (HS-252)	Fourteen modified ATLAS vehicles (including spares) (See also "Centaur")	ARDC - (Air Force)	3.50	---	----	---
NTF-12* (HS-1) (HS-46)	Lunar probe projects (see also "Scientific satellites")	AOMC (Army)	2.61	---	---	---
NTF-13* (HS-2)	Lunar probe projects	BMD (ARDC - Air Force)	2.14	---	---	---
NTF-14* (HS-3)	Lunar probe projects	NOTS (ONR - Navy)	.20	---	---	---
NTF-17* (HS-6-44) (HS-194-300-334-361-368-373-387-523)	One lunar orbiter and one deep space probe (see also "Scientific satellites")	BMD (ARDC - Air Force)	15.23	---	5.31	1.55
NTF-29* (HS-37)	Computing services (40%) (see also "Scientific satellites")	Bureau of Standards (Commerce)	.05	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Lunar and planetary explorations

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 24,478,467 OBLIGATIONS	1959 ALLOTMENT: $ 24,478,467 PENDING COMMITMENTS	1960 ALLOTMENT: $28,551,783 OBLIGATIONS	1960 ALLOTMENT: $28,551,783 PENDING COMMITMENTS
NTF-35* (HS-66)	Conduct R&D on television for space vehicles	NOTS (ONR-Navy)	.10	---	---	---
NTF-52* (HS-175)	R&D in specified areas (see also "Scientific satellites" and "Vehicle systems technology")	ABMA (Army)	.09	---	---	---
NTF-59* (HS-20) (HS-218)	Deep-space study	ABMA (Army)	.05	---	---	---
NTF-55* (HS-219)	Studies on soft lunar landings	AOMC (Army)	.15	---	---	---
NTF-6* (HS-246)	Measure natural radio-activity of the moon	NRL (ONR-Navy)	.15	---	---	---
HS-379*	Design and feasibility study of lunar surface gravity meter system	LaCoste and Romberg *	---	---	---	.06
GS-1	Research & Development Services in connection with tenancy of elements of the GSFC at NRL	NRL (ONR - Navy)	---	---	1.22	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 400 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

*Indicates contract for NASA Hdqtrs. TOTAL

NASA FORM NO. 499 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Lunar and planetary exploration

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 24,478,467 OBLIGATIONS	1959 ALLOTMENT: $ 24,478,467 PENDING COMMITMENTS	1960 ALLOTMENT: $ 28,551,783 OBLIGATIONS	1960 ALLOTMENT: $ 28,551,783 PENDING COMMITMENTS
HS-206	Date & Recording System for Lunar Probes P-14	NRL (ONR - Navy)	.08	---	---	---
NAS 5-22W GS-32	Javelion - Scout Instrumentation	Raymond Engineering Lab. Inc.	---	---	.08	---
GS-139	Rubidium Vapor Magnetometers		---	---	---	.06
GS-140	Expand and extend the Nonr-2982(00) (X) Contract		---	---	---	.07
Miscellaneous Contracts (Under $50,000)			.13	---	.05	.07
TOTAL			24.48	---	6.66	1.81

NASA FORM NO. 499 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SCIENTIFIC INVESTIGATIONS IN SPACE: Vanguard Program

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 21,943,582 OBLIGATIONS	1959 ALLOTMENT: $ 21,943,582 PENDING COMMITMENTS	1960 ALLOTMENT: $ --- OBLIGATIONS	1960 ALLOTMENT: $ --- PENDING COMMITMENTS
NS-23	Support of the Vanguard Program, Goddard Space Flight Center	NRL (ONR - Navy)	20.04	---	---	---
---	Personal services and related costs, travel and contractual services		1.45	---	---	---
NASW-109	IBM 704 program deck, SAP listing and complete analytical report	Republic Aviation Corp. *	.07	---	---	---
NAS5-7(W)	Services, Labor and materials for the construction and completion of a radio tracking station	Jones-Mahoney Corp. *	.11	---	---	---
NAS5-4(W)	Alterations and repairs to Bldg. 6, Bellevue Annex, Naval Gun Factory	Charles H. Riddle Co.*	.13	---	---	---
Miscellaneous Contracts (Under $50,000)			.01	---	---	---
TOTAL			21.81	---	---	---

NASA FORM NO. 469 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

TOTAL			21.81			

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SATELLITE APPLICATIONS: Meteorology

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $958,000 OBLIGATIONS	1959 ALLOTMENT: $958,000 PENDING COMMITMENTS	1960 ALLOTMENT: $7,930,000 OBLIGATIONS	1960 ALLOTMENT: $7,930,000 PENDING COMMITMENTS
NTF-19* (HS-11) (HS-209)	Meteorological analysis	U. S. Weather Bureau (Commerce)	.14	---	---	---
NTF-41* (HS-126)	Project Tiros	Signal Corp. (Army)	.54	---	---	---
NTF-67* (HS-262)	Modification of facilities at Kaena Point, Hawaii and operation for three months following successful launching of Tiros I	Air Force (BMD)	.28	---	---	---
NTF-60* (HS-310) (HS-471)	Meteorological analysis for F. Y. 1960	U. S. Weather Bureau	---	---	.60	---
GS-142	Utilization of measurements from Explorer VII and future satellites		---	---	---	.10
GS-1	Research & Development Services in connection with the tenancy of the GSFC at NRL	NRL (ONR - Navy)	---	---	2.77	---
NAS5-221 GS-144	Design, procure and install an Experimental Sound System	Schellenger Research Lab.*	---	---	.05	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 499 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SATELLITE APPLICATIONS: Meteorology

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $958,000 OBLIGATIONS	1959 ALLOTMENT: $958,000 PENDING COMMITMENTS	1960 ALLOTMENT: $7,930,000 OBLIGATIONS	1960 ALLOTMENT: $7,930,000 PENDING COMMITMENTS
NAS-115	Fabrication of Rocket-Grenade Instrumentation Unit	University of Michigan	---	---	.30	---
GS-18	Meteorological Satellite Radar Feasibility Study		---	---	---	.10
GS-48 MIP-67	Project Tiros read out facility at Kaena Point, Hawaii	Air Force Ballistic Div.	---	---	.15	---
HS-126	Support of Project Tiros	Department of Army Army Signal Corps	---	---	1.43	---
S-2074-G	Additional funds to U. S. Army Signal Supply Agency for Project Tiros	U. S. Army Signal Supply Agency	---	---	.05	---
GS-152	Procure Electrostatic Tape Camera		---	---	---	.35
GS-155	Design and test radiometer equipment		---	---	---	.27
GS-157	Integration of IR experiment in Tiros II		---	---	---	.40
Miscellaneous Contracts (Under $50,000)			---	---	.16	.09
TOTAL			.96	---	5.51	1.31

NASA FORM NO. 409 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SATELLITE APPLICATIONS: Communications

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $2,512,806 OBLIGATIONS	1959 ALLOTMENT: $2,512,806 PENDING COMMITMENTS	1960 ALLOTMENT: $1,400,000 OBLIGATIONS	1960 ALLOTMENT: $1,400,000 PENDING COMMITMENTS
NIY-15* (HS-4)	100-ft. inflatable sphere	AOMC (Army)	2.16	---	---	---
NASW-38* (HS-80) (HS-366)	Third stage hardware Delta space vehicle (see also "Delta")	Douglas Aircraft Co.*	.14	.02	---	.03
NASW-110* (HS-216-282-485)	Assembly and operation of a transmitting and receiving facility	Western Electric Co. *	.04	---	.13	---
HS-489*	Research program in the field of long distance communication	Lincoln Laboratory	---	---	---	.15
GS-1	Research & Development Services in connection with the tenancy of elements of the GSFC at NRL	NRL (ONR - Navy)	---	---	.05	---
S-2012 GS-90	Communication 100' Sphere	NRL (ONR - Navy)	.07	---	---	---
Miscellaneous Contracts (Under $50,000)			.09	---	---	---
*Indicates contract for NASA Hdqtrs.		TOTAL	2.50	.02	.18	.18

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $43,002,395 OBLIGATIONS	1959 ALLOTMENT: $43,002,395 PENDING COMMITMENTS	1960 ALLOTMENT: $68,602,370 OBLIGATIONS	1960 ALLOTMENT: $68,602,370 PENDING COMMITMENTS
HS-36	Atlas Boosters	BMD (Air Force)	10.43	---	10.55	---
HS-44	Redstone boosters	AOMC (Army)	8.95	---	7.16	---
HS-54	2 Jupiter boosters	AOMC (Army)	2.74	---	---	---
S-3519(G)	Support of Project Mercury HS-24 Test	AOMC (Army)	.06	---	---	---
S-1013(G)	7 XM-45 rockets (see also "earth satellites")	ABMA (Chief of Ordnance, Army)	.12	---	---	---
S-1202	5 Pressure suits	Commander, Hdqtrs. Air Materiel Command	.12	---	---	---
S-1507(G)	Test of drogue chute	Air Force Cambridge Research Center	.14	---	---	---
S-1590(G)	Test of recovery system	Naval Parachute Unit (Naval Auxiliary Air Station)	.05	---	---	---
S-1705(G)	Drop tests	U. S. Atomic Energy Commission	.12	---	---	---
S-1714(G)	Pressure Suits	Bureau of Aeronautics (Navy)	.10	---	---	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

TOTAL						

NASA FORM NO. 469 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $43,002,395 OBLIGATIONS	1959 ALLOTMENT: $43,002,395 PENDING COMMITMENTS	1960 ALLOTMENT: $68,602,370 OBLIGATIONS	1960 ALLOTMENT: $68,602,370 PENDING COMMITMENTS
NAS5-51	Booster hardware, four sets for TX-33	Aerolab Development Co.*	.07	---	---	---
NAS5-55	24 XM-19E1 rockets	Thiokol, Inc.*	.11	---	---	---
NAS5-59	12 capsule systems, 12 ablation and 6 berylium heat shield, 6 escape and 6 retrorocket systems, 9 adapter sections, 9 release mechanisms, a mockup of the capsule system	McDonnell Aircraft Corp.*	15.79	---	34.29	---
NAS5-86	Simulated altitude test facility	Tenney Engineering, Inc.*	.08	---	---	---
NAS5-63	Ablation heat shields	Cincinnati-Testing & Research Lab.*	.12	---	---	---
NAS5-69	Landing & recovery system	Radioplane, A Division of Northrop Corp.*	.06	---	---	---
NAS5-80	Rental of analog computer service	Electronic Associates, Inc.*	.07	---	---	---
NAS5-96	Pilots Capsule Access Tower	Mobile Aerial Tower, Inc.*	---	---	.06	---
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 469 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 43,002,395 OBLIGATIONS	1959 ALLOTMENT: $ 43,002,395 PENDING COMMITMENTS	19[illegible] ALLOTMENT: $ 68,602,370 OBLIGATIONS	19[illegible] ALLOTMENT: $ 68,602,370 PENDING COMMITMENTS
L-55,931(G)	16 TX-33-20 rockets, 12 TX-33-22 rockets (see also "earth satellites")	ABM (Chief of Ordnance, Army)	2.19	---	---	---
S-3506(G)	Emergency operation support	Air Force Missile Test Center	.06	---	---	---
NAS5-91	S/M mobile radio squadron semi-trailers	Gichner Iron Works, Inc.*	.06	---	---	---
G-9Z-71	Ground support equipment		---	---	---	.05
S-97-4	Ground support equipment		---	---	---	.05
G-9X-1	Ground support equipment		---	---	---	.10
G-9X-5	Ground support equipment		---	---	---	.45
G-9X-16	Retrograde rocket re-design		---	---	---	.80
G-9Y-29	Ground support equipment		---	---	---	.06
G-98-49	Ground support equipment		---	---	---	.30
G-98-42	Telemetry trailers		---	---	---	.79
G-98-51	Ground support equipment		---	---	---	1.66
G-99-3	Ground support equipment		---	---	---	.06
Miscellaneous Contracts (Under $50,000)						
TOTAL						

NASA FORM NO. 469 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 43,002,395 OBLIGATIONS	1959 ALLOTMENT: $ 43,002,395 PENDING COMMITMENTS	1960 ALLOTMENT: $ 68,602,370 OBLIGATIONS	1960 ALLOTMENT: $ 68,602,370 PENDING COMMITMENTS
G-97-21	Ground support equipment		---	---	---	.23
G-98-32	Capsule spare parts		---	---	---	.27
G-9Z-128	Ground support equipment		---	---	---	.07
G-01-16	Decommutation station and associated equipment		---	---	---	.09
G-01-19	Telereaders for IBM		---	---	---	.05
G-02-80	Posigrade rocket firing signal		---	---	---	.10
G-02-90	Procedures Trainers		---	---	---	.20
G-02-113	Project Mercury Spare parts program		---	---	---	.50
G-02-121	Excape Tower Ballast weight reduction		---	---	---	.14
G-03-2	Recovery beacon system		---	---	---	.30
G-03-8	Ground support equipment		---	---	---	.75
G-03-26	Equipment for posigrade firing test		---	---	---	.09
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: MANNED SPACE FLIGHT

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 43,002,395 OBLIGATIONS	1959 ALLOTMENT: $ 43,002,395 PENDING COMMITMENTS	1960 ALLOTMENT: $ 68,602,370 OBLIGATIONS	1960 ALLOTMENT: $ 68,602,370 PENDING COMMITMENTS
G-02-34	Provisions for ECS test vessels		---	---	---	.15
NASW-90* (HS-174)	Evaluate KO_2 and NaO_2 Compositions for use as an Oxygen supply	MSA Research Corp. *	.07	---	---	---
NTF-66*	Provide one Jupiter launched recoverable animal Payload	Office of Surgeon General (Army)	.15	---	---	---
NTF-74* (HS-266)	Biological systems in interplanetary environment	AEC	.09	---	---	---
NASW-95* (HS-215)	Design, develop and fabricate a prototype of a closed ecological system	General Dynamics Corp.* Electric Boat Div.	.12	---	---	---
Miscellaneous Contracts (Under $50,000)			1.13	---	.14	.68
* Indicates contract for NASA Hdqtrs.		TOTAL	43.00	---	52.20	7.94

NASA FORM NO. 449 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Solid Rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $615,898 OBLIGATIONS	1959 ALLOTMENT: $615,898 PENDING COMMITMENTS	1960 ALLOTMENT: $1,730,000 OBLIGATIONS	1960 ALLOTMENT: $1,730,000 PENDING COMMITMENTS
NASW-29* (HS-72)	Exploratory R & D on propellants	Callary Chemical Co. *	.17	---	---	---
NASW-60* (HS-113)	Studies of solid propellant motors	Lockheed Aircraft Corp. *	.05	---	---	---
NASW-51* (HS-123)	Demonstrate feasibility of unique design of rocket engines	Grand Central Rocket Corp.*	.18	---	---	---
NASW-67* (HS-151)	Investigate performance of refractory materials on rocket nozzle liners	ARDE - Portland Inc. *	.09	---	---	---
NASW-64* (HS-163)	Investigate effects of sonic energy on solid propellant burning rates	Acoustica Associates Inc. *	.09	---	---	---
HS-437*	Prototype system for altitude and velocity control of solid propellant rocket engines		---	---	---	.20
HS-522*		North American Aviation *	---	---	---	.20
GH-12/60*	Fabricate and static fire three solid rocket motors		---	---	---	.15
Miscellaneous Contracts (Under $50,000)			.04	---	.05	.02
*Indicates contract for NASA Hdqtrs.		TOTAL	.62	---	.05	.57

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Liquid Rockets

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $11,913,589 OBLIGATIONS	1959 ALLOTMENT: $11,913,589 PENDING COMMITMENTS	1960 ALLOTMENT: $ 26,590,000 OBLIGATIONS	1960 ALLOTMENT: $ 26,590,000 PENDING COMMITMENTS
NTF-20* (HS-13)	"State-of-art" work on rocket engines	WADC (ARDC-Air Force)	.43	---	---	---
NASW-16* (HS-10) (HS-356)	1,000,000 lb. thrust rocket engine	Rocketdyne Division of North American Aviation Inc. *	10.00	---	23.00	---
NASW-28* (HS-76) (HS-197-347-418-419-420-421)	Feasibility of liquid fluorine-liquid hydrogen in a rocket engine	Bell Aircraft Corp. *	1.07	.02	.12	.28
NASW-40* (HS-127)	Investigate feasibility of plug nozzle rocket thrust chamber	General Electric Co.*	.39	---	---	---
NTF-91* (HS-383)	Propellants for use under contract NASW-16	Air Force	---	---	.05	1.15
GH-2/60*	200,000 lb. thrust liquid oxygen-hydrogen engine		---	---	---	1.70
Miscellaneous Contracts (Under $50,000)			---	---	---	---
*Indicates contract for NASA Hdqtrs.	TOTAL		11.89	.02	23.17	3.13

NASA FORM NO. 488 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: VEHICLE SYSTEMS TECHNOLOGY

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $1,310,000 OBLIGATIONS	1959 ALLOTMENT: $1,310,000 PENDING COMMITMENTS	1960 ALLOTMENT: $1,339,651 OBLIGATIONS	1960 ALLOTMENT: $1,339,651 PENDING COMMITMENTS
NIF-52* (HS-175)	R & D in specified areas (see also "Scientific satellites" and "Lunar and planetary explorations")	ABMA (Army)	.81	---	---	---
HS-179*	Eight recovery units and launch support		---	.50	---	---
Miscellaneous Contracts (Under $50,000)			---	---	.01	---
*Indicates contract for NASA Hdqtrs. TOTAL			.81	.50	.01	---

NASA FORM NO. 499 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Nuclear systems technology

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $3,710,496 OBLIGATIONS	1959 ALLOTMENT: $3,710,496 PENDING COMMITMENTS	1960 ALLOTMENT: $5,800,000 OBLIGATIONS	1960 ALLOTMENT: $5,800,000 PENDING COMMITMENTS
NTF-21 * (HS-15) (HS-413)	Rover program	Atomic Energy Commission	1.90	---	1.42	---
NASW-48 * (HS-146)	Analyze topping turbine cycle for application to nuclear rockets	Aerojet General Corp. *	.09	---	---	---
NASW-104 * (HS-192)	Investigation of spectral and total emissivity and reflectivity	Pratt and Whitney *	.10	---	---	---
HS-225 *	Evaluation of radiation effects on materials operating in cryogenic temperatures		---	1.00	---	---
HS-407*	Development of conversion system	Atomic Energy Commission	---	.60	---	1.00
HS-436 *	Work in corrosion characteristics of boiling and condensing potassium		---	---	---	.30
NASW-132	Research & development on shielding for Space Vehicles.	Technical Research Group Inc. *	---	---	.05	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs. TOTAL						

NASA FORM NO. 449 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 400 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Nuclear systems technology

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 3,710,496 OBLIGATIONS	1959 ALLOTMENT: $ 3,710,496 PENDING COMMITMENTS	1960 ALLOTMENT: $ 5,800,000 OBLIGATIONS	1960 ALLOTMENT: $ 5,800,000 PENDING COMMITMENTS
NTF-92 * (HS-442)	Experimental studies on properties of sodium	NRL (ONR - Navy)	---	---	.05	---
HS-475 *	Turbine and gas turbine drive system	Atomic Energy Commission	---	---	---	.20
GH-8/60*	Determination of Thermodynamic and transport properties of Potassium, sodium, & rubidium		---	---	---	.15
GH-9/60*	Development of a liquid hydrogen cooled jet nozzle		---	---	---	.45
GH-14/60*	Development of methods for calculating the effectiveness of a shield for nuclear reactors		---	---	---	.08
GH-16/60*	Determine physical properties of hydrogen & develop instrumentation for liquid hydrogen systems		---	---	---	.15
	Miscellaneous Contracts (Under $50,000)		.02	---	---	---
* Indicates contract for NASA Hdqtrs.		TOTAL	2.11	1.60	1.52	2.33

NASA FORM NO. 400 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SPACE PROPULSION TECHNOLOGY: Space Power Technology

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ --- OBLIGATIONS	1959 ALLOTMENT: $ --- PENDING COMMITMENTS	1960 ALLOTMENT: $ 3,720,000 OBLIGATIONS	1960 ALLOTMENT: $ 3,720,000 PENDING COMMITMENTS
HS-408*	Research on thermal and physical properties of lithium hydride	Atomic Energy Commission	---	---	---	.17
HS-454*	Initial development of a plasmajet rocket engine		---	---	---	.50
HS-455*	One kilowatt plasmajet rocket engine		---	---	---	.20
HS-497*			---	---	---	1.60
GH-1/60*	Ion rocket engine development using an alkali metal as a propellant		---	---	---	.45
Miscellaneous Contracts (Under $50,000)			---	---	---	---
*Indicates contract for NASA Hdqtrs. TOTAL			---	---	---	2.92

NASA FORM NO. 400 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: VEHICLE DEVELOPMENT: Scout

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $3,932,000 OBLIGATIONS	1959 ALLOTMENT: $3,932,000 PENDING COMMITMENTS	1960 ALLOTMENT: $1,368,500 OBLIGATIONS	1960 ALLOTMENT: $1,368,500 PENDING COMMITMENTS
S-1000(G)	8 X-248 rockets	Bureau of Ordnance (Navy)	.10	---	---	---
S-1010(G)	8 X-254 rockets	Bureau of Ordnance (Navy)	1.12	---	---	---
S-1013(G)	5 XM-45 rockets (see also "Manned space flight")	ABMA (Chief of Ordnance Army)	.09	---	---	---
NAS5-53	8 Jupiter seniors	Aerojet Gen. Corp.*	1.02	---	---	---
	9 Transtainers	Aerojet Gen. Corp. *	.17	---	---	---
NAS5-61	Attitude control system	Minneapolis Honeywell Reg. Co. *	.77	---	---	---
L-55,931(G)	8 TX-33-20 rockets (see also "Manned space flight")	ABM (Chief of Ordnance Army)	.62	---	---	---
Miscellaneous Contracts (Under $50,000)			.03	.01	---	---
TOTAL			3.92	.01	---	---

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: VEHICLE DEVELOPMENT: Delta

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 12,927,417 OBLIGATIONS	1959 ALLOTMENT: $ 12,927,417 PENDING COMMITMENTS	1960 ALLOTMENT: $ 13,300,000 OBLIGATIONS	1960 ALLOTMENT: $ 13,300,000 PENDING COMMITMENTS
NASW-38* (HS-80) (HS-241) (HS-388-459-476-496)	Delta space vehicle (see also "Communications")	Douglas Aircraft Co. *	6.90	.02	10.20	.24
NIF-1* (HS-162)	Eleven THOR missiles	BMD (Air Force)	5.61	---	---	---
NIF-70* (HS-185)	Sixteen X248A5 Delta rocket motors (see also "Communications")	Bureau of Ordnance (Navy)	.14	---	---	---
NIF-65* (HS-324) (HS-435)	Operation of computers and post-flight analysis of data for seven Delta launchings	BMD (Air Force)	---	---	.63	---
HS-364*	Engineering, design, hardware and installation of C-Band Beacons and Command Destruct Receivers	Douglas Aircraft Co.*	---	---	---	.18
GS-1	Research & Development Services in connection with the tenancy of elements at the GSFC at NRL	NRL (ONR - Navy)	---	---	.05	---
Miscellaneous Contracts (Under $50,000)			---	.01	---	---
*Indicates contract for NASA Hdqtrs.		TOTAL	12.65	.03	10.88	.42

NASA FORM NO. 449 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

*Indicates contract for NASA Hdqtrs.	TOTAL		12.65	.03	10.88	.42

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT: Vega

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 11,202,494 OBLIGATIONS	1959 ALLOTMENT: $ 11,202,494 PENDING COMMITMENTS	1960 ALLOTMENT: $ 1,600,000 OBLIGATIONS	1960 ALLOTMENT: $ 1,600,000 PENDING COMMITMENTS
NASW-30 * (HS-103) (HS-274) (HS-363) (HS-428-429) (HS-440-472)	Development of liquid propellant rocket engine and ground support equipment and second stage testing	General Electric Co. *	4.12	.08	1.09	.44
NASW-45 * (HS-164) (HS-360)	Eight Vega second-stage vehicles, 1 Vega for captive firing tests and design, develop, test and fabricate nose cone fairings	Convair Astronautics Division * General Dynamics Corp. *	7.00	---	---	.06
Miscellaneous Contracts (Under $50,000)			---	---	---	---
* Indicates contract for NASA Hdqtrs.	TOTAL		11.12	.08	1.09	.50

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT: Centaur

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 4,000,000 OBLIGATIONS	1959 ALLOTMENT: $ 4,000,000 PENDING COMMITMENTS	1960 ALLOTMENT: $ 36,250,000 OBLIGATIONS	1960 ALLOTMENT: $ 36,250,000 PENDING COMMITMENTS
NTF-57 * (HS-302-362-458)-481	Provide for work on Centaur for the fiscal year 1960 (Contract AF 18 (600) - 1774)	ARDC (Air Force)	---	---	14.50	---
NTF-4 * (HS-439) (HS-252)	Six Centaur Atlases have been added to this "Vega" contract with no additional funding at this time (see also "Lunar and planetary exploration")	BMD (Air Force)	4.00	---	---	---
NTS-96 * (HS-458)	Continue work on Centaur (Contract AF 18 (600)-1774)	ARDC (Air Force)	---	---	19.00	---
S-2111-G HS-480 *	Four XLR-115-P-1 engines and necessary field service	WDZC - (AFBDM)	---	---	1.10	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
* Indicates contract for NASA Hdqrts. TOTAL			4.00	---	34.60	---

NASA FORM NO. 409 (SEPTEMBER 1958)

NOTE: Figures in millions of dollars

					34.00	

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: GODDARD SPACE FLIGHT CENTER

MONTH AND YEAR: February, 1960

PROGRAM: VEHICLE DEVELOPMENT: Saturn

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ OBLIGATIONS	1959 ALLOTMENT: $ PENDING COMMITMENTS	1960 ALLOTMENT: $ 1,500,000 OBLIGATIONS	1960 ALLOTMENT: $ 1,500,000 PENDING COMMITMENTS
NTF-101 * (HS-511)	To permit acceleration of the Saturn vehicle development program	ABMA (Huntsville, Alabama)	---	---	1.50	---
Miscellaneous Contracts (Under $50,000)			---	---	---	---
*Indicates contract for NASA Hdqtrs. TOTAL			---	---	1.50	---

NASA FORM NO. 449 (SEPTEMBER 1958) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SUPPORTING ACTIVITIES

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,231,070 OBLIGATIONS	1959 ALLOTMENT: $ 2,231,070 PENDING COMMITMENTS	1960 ALLOTMENT: $ 12,236,183 OBLIGATIONS	1960 ALLOTMENT: $ 12,236,183 PENDING COMMITMENTS
NASW-7* (HS-14) GS-7	Operation of earth satellite radio tracking and receiving stations for six months beginning January 1, 1959	Government of Peru	.07	---	.11	---
NASW-11* (HS-17)	Operations of Minitrack stations in South America and Cuba for 18 months beginning January 1, 1959	Bendix Radio Corporation *	.86	---	---	---
NASW-19* (HS-16)	Operations of 2 earth satellite tracking and receiving stations beginning January 1, 1959	University of Chile	.07	---	---	---
HS-22*	Photo reduction equipment	Smithsonian Astrophysics Laboratory	.14	---	---	---
HS-32* (HS-330-331-378)	Tracking and data reduction services to end of FY 1960	Smithsonian Institution	.47	---	2.52	---
NTF-38 (HS-115)	Procurement test equipment for telemetry stations	NRL (ONR-Navy)	.38	---	---	---
NASW-68* (HS-227)	Use of radio telescope	University of Manchester	.18	---	---	---
Miscellaneous Contracts (Under $50,000)						
*Indicates contract for NASA Hdqtrs.		TOTAL				

NASA FORM NO. 449 (SEPTEMBER 1959)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SUPPORTING ACTIVITIES

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $2,231,070 OBLIGATIONS	1959 ALLOTMENT: $2,231,070 PENDING COMMITMENTS	1960 ALLOTMENT: $12,236,183 OBLIGATIONS	1960 ALLOTMENT: $12,236,183 PENDING COMMITMENTS
NIF-72* (HS-335)	Support of Fort Churchill through September 1959	Research & Development (Army)	---	---	.65	---
NASW-119* (HS-365)		Martin Company *	---	---	.03	.05
GS-1	Research & Development Services in connection with the tenancy of elements at the GSFC at NRL	NRL (ONR - Navy)	---	---	2.88	---
NASW-19	Two earth satellite radio tracking and receiving stations	University of Chile	---	---	.24	---
NAS5-5(w) GS-4	Operation of Minitrack Stations for 1960 by Bendix	Bendix Radio, Division of Bendix Aviation Corp. *	---	---	2.02	---
GS-14	Architect Engineer Services and site construction cost for Minitrack Station in Newfoundland	Canadian Commercial Corp. *	---	---	.05	---
	Miscellaneous Contracts (Under $50,000)					
*Indicates contract for NASA Hdqtrs.	TOTAL					

NASA FORM NO. 449 (SEPTEMBER 1959) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: Goddard Space Flight Center

MONTH AND YEAR: February 1960

PROGRAM: SUPPORTING ACTIVITIES

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ 2,231,070 OBLIGATIONS	1959 ALLOTMENT: $ 2,231,070 PENDING COMMITMENTS	1960 ALLOTMENT: $ 12,236,183 OBLIGATIONS	1960 ALLOTMENT: $ 12,236,183 PENDING COMMITMENTS
NAS5-6(w)	Call orders in connection with NASA Satellite Tracking Program	Bendix Radio, Division of Bendix Aviation Corp. *	---	---	.10	---
GS-84	Transfer funds to NAS5-6 (w)		---	---	---	.05
GS-96	Additional funds to NAS5-6 (w) for Minitrack Calibration System		---	---	---	.35
NASW-112	Computing services	CEIR *	---	---	.20	---
NIF-5	For services of computing systems	National Bureau of Standards	---	---	.20	---
GS-100	Additional funds for Contract NIF-5		---	---	---	.10
S-2328-G	Funding for Communication radio teletype lines and equipment for third and fourth quarters FY 1960	Department of the Army	---	---	.20	---
Miscellaneous Contracts (Under $50,000)			---	---	.15	.13
TOTAL			2.17	---	9.35	.68

NASA FORM NO. 449 (SEPTEMBER 1960)

NOTE: Figures in millions of dollars

NASA FORM NO. 449 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SELECTED RESEARCH AND DEVELOPMENT CONTRACTS

REPORTING INSTALLATION: WALLOPS STATION

MONTH AND YEAR: February, 1960

PROGRAM: ADVANCED RESEARCH PROGRAMS: Support of NASA Plant

CONTRACT NO.	PURPOSE	CONTRACTOR	1959 ALLOTMENT: $ --- OBLIGATIONS	1959 ALLOTMENT: $ --- PENDING COMMITMENTS	1960 ALLOTMENT: $ 807,000 OBLIGATIONS	1960 ALLOTMENT: $ 807,000 PENDING COMMITMENTS
L-70,934	Fuel Oil (No. 2)	Tidewater Oil Co. *	---	---	.02	.04
P-109	Fuel Oil (No. 6)	Princess Anne Petroleum Co.*	---	---	.05	.03
P-407(G)	Operation of a range meteorological support station	U.S. Weather Bureau	---	---	.06	---
97-58	Services to maintain one AN/FPS radar		---	---	---	.06
Miscellaneous Contracts (Under $50,000)			---	---	.38	.17
TOTAL			---	---	.51	.30

NASA FORM NO. 449 (SEPTEMBER 1960) NOTE: Figures in millions of dollars

ESTIMATED VEHICLE AND PAYLOAD COSTS

Mr. LEHRER. There are two additional items we would like you to submit for the record. We have had considerable testimony on the various types of space vehicles and payloads you are developing. Could you give us the costs of each of the types of space vehicles exclusive of payload, and also cost data on various types of representative payloads?

And secondly, would you list the various NASA programs and indicate for each of the boosters who the major contractors and subcontractors are?

Mr. HORNER. I will be glad to provide that information.

(The information is as follows:)

ESTIMATED COST PER VEHICLE

For the purpose of this statement, the cost of each vehicle, exclusive of the payload, was estimated as follows:

Cost includes: Labor and materials to produce engines, guidance systems, vehicle instrumentation, etc.

Cost does not include: Development costs, ground-support equipment, transportation, launching costs, etc.

Delta	$2,600,000
Scout	750,000
Agena-Thor booster	3,410,000
Atlas booster	4,810,000
Centaur	7,500,000

EXAMPLES OF PAYLOAD COSTS

Information is supplied below on examples of payload (spacecraft) costs. The question posed used the word "representative" instead of "examples of" payload costs. To be fully responsive to the question, it must be emphasized that the costs of "payloads" can vary from less than $100,000 for the smaller sounding rocket payloads (near space probes) to tens of millions for payloads (spacecraft) now being developed and in planning for the increasingly complex missions utilizing advanced booster vehicle systems such as Agena, Centaur, and Saturn. The cost of a given payload depends on many factors including size, complexity, time duration of the mission, and the amount of research and development effort particularly in advanced technology required to be performed before the payload can be constructed.

2. It is difficult and also meaningless to cite the reproduction cost of constructing the final flight article. This would be merely a manufacturing cost which would in no way reflect the amount of effort and resources applied to a given project. Each payload launched is a final prototype. In order to get to the article which actually flies, several units are developed and constructed for development and test purposes to make sure the spacecraft will perform its mission in flight. Payload costs must also include the cost of special ground equipment required to control the spacecraft in flight, and secure the data emitted by the instrumentation. For example:

(*a*) *Project Tiros.*—Total payload costs, $14.5 million.

This includes the development and fabrication of three flight payloads: Two Tiros I type, one of which is in orbit, and one flight backup which was in the Capitol on exhibition last week; one Tiros II flight model (containing infrared sensing devices in addition to the television in Tiros I), plus one prototype for test purpose and one complete set of spares for backup and test purposes. The $14.5 million includes the special ground equipment required to operate the payload system in flight.

(*b*) *Explorer VI (scientific earth satellite).*—Total payload cost, $6.7 million.

(*c*) *Pioneer V (scientific deep space probe).*—Total payload cost, $6.4 million.

3. The complete cost of the above three successful flights will, of course, not obtainable until the spacecraft have completed their active missions and the data has been finally reduced and analyzed and reports published and disseminated.

NASA LAUNCH VEHICLE PROGRAMS; MAJOR CONTRACTOR AND A PARTIAL LISTING OF SUBCONTRACTORS

Scout

Major contractor: None; the Langley Research Center is acting in this capacity at present.

Subcontractors: Chance Vought Aircraft, Inc., Aerojet-General Corp., Thiokol Chemical Corp., Allegany Ballistics Laboratory (a Navy BUWEPS facility operated by the Hercules Powder Co.), Minneapolis-Honeywell Regulator Co., and Walter Kidde & Co., Inc.

Delta

Major contractor: Douglas Aircraft Co., Inc.

Subcontractors: Rocketdyne, a division of North American Aviation, Inc., Aerojet-General Corp., Allegany Ballistics Laboratory (a Navy BUWEPS facility operated by the Hercules Power Co.), Bell Telephone Laboratories of the Western Electric Co., and Minneapolis-Honeywell Regulator Co.

Centaur

Major contractor: Convair (Astronautics), division of the General Dynamics Corp. Associate contractor: Pratt & Whitney Aircraft, division of United Aircraft Corp.

Subcontractors: Rocketdyne, a division of North American Aviation, Inc., Bell Aircraft Corp., Minneapolis-Honeywell Regulator Co., the General Electric Corp., Pesco Products Division of the Borg-Warner Corp., and Librascope-Division of General Precision, Inc.

Agena B

Major contractor: Lockheed Aircraft Corp.

Subcontractors: Bell Aircraft Corp., Douglas Aircraft Co., Inc., Rocketdyne, a division of North American Aviation, Inc.

Saturn

Major contractor: None; the Marshall Space Flight Center is acting in this capacity.

Mr. LEHRER. That is all, Mr. Chairman.

Senator STENNIS. All right, Mr. Horner, and the other gentlemen who are here who testified at these hearings. We want to thank you again for your attention. You have an amazing program here of tremendous interest. I think your message about what you are doing is getting through more and more to the public, but it is greatly needed even further.

I have been intrigued by the point that has been made here that I never had heard explained exactly, that it is better to advertise our so-called failures in this program. I don't know that I have ever agreed with that, but it seems like we have stopped worrying about those things anyway as much as we did.

Is there anything else now that you wish to say, Mr. Horner or any other one that is before the committee? These hearings will perhaps be closed tomorrow. After the record goes to the printer, why it is too late then to say anything or put anything in the record; but it will be kept open a few days for those who might wish to put in anything else.

Mr. HORNER. I have nothing further, Mr. Chairman.

Senator STENNIS. Dr. Silverstein, do you have anything further?

Dr. SILVERSTEIN. No, thank you.

Mr. HORNER. I certainly want to thank you, Mr. Chairman, and members of the committee for your detailed attention to our program.

Senator STENNIS. I have been very pleased that we had as good attendance today as we did, especially in view of the important bill that is being taken up on the floor of the Senate.

All right, I believe every one has had his say then today. Gentlemen, with thanks again of the subcommittee, we will now take a recess until 10 o'clock tomorrow morning.

(Whereupon, at 5 p.m. the hearing was recessed, to reconvene at 10 a.m. Wednesday, March 30, 1960.)

NASA AUTHORIZATION FOR FISCAL YEAR 1961

WEDNESDAY, MARCH 30, 1960

U.S. SENATE,
NASA AUTHORIZATION SUBCOMMITTEE OF THE
COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 235, Old Senate Office Building, Senator Stephen Young presiding.

Present: Senators Stennis, Smith, Young, Cannon, Martin, Wiley, and Symington.

Also present: Max Lehrer, assistant staff director; Everard H. Smith, Jr., counsel; William J. Deachman, assistant counsel; Dr. Glen P. Wilson, chief clerk; Dr. Earl W. Lindveit, assistant chief clerk.

Senator YOUNG. The hearing will come to order.

Dr. York, you will be the first witness.

Will you, following the custom of this subcommittee, stand and be sworn.

Dr. York, do you solemnly swear that the testimony you will give in this hearing will be the truth, the whole truth, and nothing but the truth, so help you God?

Dr. YORK. I do.

Senator YOUNG. Now, we expect that this will be the final hearing of this subject. It is our hope that as there are two witnesses, if we Senators don't ask too many questions, that this hearing will be completed by about noon, so that those of us who are here may go over and participate in the civil rights debate.

As acting chairman, I have a short statement to make before testimony commences.

HEARINGS TO COVER MILITARY SPACE PROGRAMS

This morning the NASA Authorization Subcommittee will hear in open session two witnesses from the Department of Defense to discuss military programs.

Our first witness will be Dr. Herbert York, Director of Defense Research and Engineering. Following Dr. York's testimony, the commtitee will hear from Lt. Gen. Bernard A. Schriever, commander of the Air Research and Development Command. General Schriever has just arrived at the airport, and he will be here in ample time.

On March 4, Senator Lyndon B. Johnson, chairman of the Aeronautical and Space Sciences Committee requested the Secretary of Defense to provide the committee with a comprehensive statement covering the nature, status, and funding history of each space or space-related activity or program included in the Department of Defense appropriation request for the fiscal year 1961.

53795 O—60—pt. 1——30

He also requested a complete chronology covering development of the fiscal year 1961 budget request for the space and space-related activities for the Department of Defense for fiscal year 1961.

The committee has received certain information from the Department of Defense in response to the chairman's request. A great deal of this information is of necessity classified. The Department of Defense has been requested to review the material submitted, so that whatever can be properly declassified may be included in the record.

We will place in the record at this point the chairman's letter to the Secretary of Defense, and the declassified portion of the Department of Defense reply.

There is no objection to that, is there, Senator Smith?

Senator SMITH. I have no objection.

(The material referred to is as follows:)

MARCH 4, 1960.

Hon. THOMAS S. GATES, Jr.,
The Secretary of Defense,
Washington, D.C.

DEAR MR. SECRETARY: As you know, the Congress has been requested to authorize the appropriation of $915 million to the National Aeronautics and Space Administration for the fiscal year 1961.

Because of the close interrelationship between the military and civilian space programs, it is necessary for this committee to consider both the military and civilian aspects in evaluating the NASA authorization request for fiscal year 1961.

Accordingly, it is requested that this committee be furnished with a comprehensive statement covering the nature, status, and funding history of each space or space-related activity or program included in the Department of Defense appropriation request for fiscal year 1961. The term "space-related" is meant to include such programs as Dynasoar, X–15, missile ranges, satellite detection and surveillance, etc.

It would be helpful if the comprehensive statement requested above were supplemented by a complete chronology covering development of the fiscal year 1961 budget request for the space and space-related activities of the Department of Defense for fiscal year 1961. In addition, please furnish us with four copies of all budget justification material for these activities. This supplementary material should include the complete budget justification for the advanced research projects agency.

Your cooperation in this matter is appreciated.

Sincerely,

LYNDON B. JOHNSON, *Chairman.*

THE SECRETARY OF DEFENSE,
Washington, March 28, 1960.

CHAIRMAN, COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES,
U.S. Senate.

DEAR MR. CHAIRMAN: In response to your letter of March 4, 1960, concerning your review of the appropriation of $915 million to the National Aeronautics and Space Administration for fiscal year 1961, there was forwarded to you by letter of March 8, 1960, budget justification material on those activities in the Department of Defense programs which are space related.

To amplify the material already furnished, there is provided herein information covering the nature, status, and funding history of the major Department of Defense activities relating to space. These activities are integrated, as systems or subsystems, into the overall military program areas wherever there is a potential capability for accomplishing a military task more effectively or more economically. Continuous coordination is effected between the Department of Defense and the National Aeronautics and Space Administration to insure cross-fertilization of ideas and developments and to avoid unnecessary duplica-

tion. The program amounts for fiscal year 1960 and fiscal year 1961 are those shown in the President's budget. However, revised development plans are under review and some program changes appear to be warranted.

1. COMMUNICATIONS PROJECT (CODE NAME, NOTUS)

(*a*) *Objective.*—Development of an adequate, reliable, secure, and disturbance free long-range military communications system through the use of appropriately designed and orbited space satellites.

(*b*) *Program.*—There are two major efforts; first, Courier, a delayed repeater communications project; second, Advent, an active instantaneous repeater satellite system.

The Courier satellites, scheduled for launching in the third quarter of calendar year 1960 from the Atlantic Missile Range (AMR), will contain several receivers and transmitters with associated tape recorders. As the Courier satellite passes over a designated ground station, a command will be given to receive a message being transmitted to it from the station. At the next ground station the satellite, upon electronic command, will transmit the message picked up at the previous ground station and stored in the satellite's tape recorder. An experimental stationary ground station in Puerto Rico is being provided, and a transportable station will be used in the United States.

The Advent communications project provides for three satellites equally spaced around the earth in a 19,200 nautical-mile equatorial orbit. In this orbit, the satellite will remain approximately stationary over one point on the earth. Several satellites in polar orbit will fill in the polar regions. The objective of this project is to prove the feasibility of complete global communications for ground-to-ground, ground-to-ship, and ground-to-aircraft transmission.

A total of [deleted] satellite launches is planned in the research and development program which is scheduled for completion in [deleted].

c. Funding history

[In millions]

Notus:	
Prior years	$16.7
Fiscal year 1960	38.8
Fiscal year 1961	42.0

2. NAVIGATION SATELLITE PROJECT (CODE NAME, TRANSIT)

(*a*) *Objective.*—Improvement in the present capability of ships and aircraft in navigation techniques with particular regard to precision of navigation, worldwide coverage, simplicity of mobile navigation equipment, and all-weather capability.

(*b*) *Program.*—The program consists of a series of satellite launchings into accurately determined orbits. The satellites are equipped with special radio transmitters which provide coded information and a time signal. By use of this information in conjunction with tables and by use of doppler techniques, it is expected that observing ships and planes can determine their positions to an accuracy within a fraction of a mile.

Although the first Transit satellite launched in September 1959 failed to achieve orbit, data obtained prior to reentry of the payload indicated the practicality of the system. Three additional launches are planned in 1960 to complete the research and development phase of the program.

NOTE: Transit I–B was successfully launched on April 13, 1960; see footnote, page 31.

c. Funding history

[In millions]

Transit:	
Prior years	$10.6
Fiscal year 1960	16.8
Fiscal year 1961	7.0

3. SATELLITE TRACKING PROJECT (CODE NAME, SHEPHERD)

(*a*) *Objective.*—To provide a means by which all satellites can be rapidly detected, tracked, identified, and cataloged.

(*b*) *Program.*—There are two major aspects of the space surveillance project. The first part is the development of Spasur, a satellite-detection fence to detect, track, and assist in identifying silent or uncooperative satellites. The fence, a modified active minitrack system, consists of a series of stations constructed across the southern United States. The fence is now in operational use with certain improvements in its capabilities anticipated.

The other part of the project consists of developing technical specifications to establish a National Space Surveillance and Control Center. The research and development toward this objective is being done at Spacetrack. When fully developed, this center will be the central point for data reduction, analysis, cataloging, and dissemination of all ephemeris information acquired from all earth satellites and space vehicles. After the satellite data acquired has been processed by Spacetrack, it is sent out, as needed, to all military, intelligence, and scientific agencies entitled to receive it. Initial research and development has progressed to the point of limited operations at the Cambridge installation.

c. Funding history

[In millions]

Shepherd:	
Prior years	$31.9
Fiscal year 1960	12.0
Fiscal year 1961	18.0

4. DISCOVERER, SAMOS AND MIDAS PROJECTS

(*a*) *Discoverer objective.*—To conduct a research and development program directed toward developing a satellite vehicle (Agena), and to demonstrate the operation of subsystems which include guidance and control, stabilization of the vehicle in orbit, techniques and procedures for tracking, acquisition and command of the vehicle in orbit and recovery of a capsule from orbit. The basic Agena vehicle and engineering developments derived from the Discoverer program will be applied to many other military space projects including Samos and Midas.

(*b*) *Discoverer program.*—The current Discoverer project provides for [deleted] vehicles, all launched into polar orbits from the Pacific Missile Range (PMR) using the Thor IRBM as a booster. A complex of tracking and acquisition stations for control during launch and orbit has been installed at locations in Alaska, Hawaii and in California. To support the operation, there is also a data recovery capsule task force consisting of aircraft and ships operating out of Hawaii to effect air and/or water recovery of the capsules. To date, there have been 10 Discoverer launches, 6 of which achieved orbit. Despite the 4 out of 10 failures to achieve orbit, the Discoverer program is considered to be successful in that all major objectives except recovery have been demonstrated. The Agena vehicle from the standpoint of propulsion, guidance and control, command acquisition and stabilization, has proven to be a reliable space vehicle and promises to be extremely useful in many other programs. In the recovery sequence, telemetered information has provided indications of needed design changes which are being incorporated.

Samos (Reconnaissance satellite project)

(*c*) *Samos objective.*—The development of a capability to provide a satellite reconnaissance system to acquire, process, and distribute visual (photographic) [deleted] reconnaissance information useful to the defense of the United States. [Deleted.]

(*d*) *Samos program.*—The Samos project derives much of its basic engineering from the Discoverer project and includes such items as the Agena satellite vehicle and applicable portions of the ground station complex and operating techniques. Use of Atlas boosters instead of the Thor provides for increased payload carrying capability so that the [deleted] payloads being developed in the Samos project can be tested in orbit. All Samos vehicles will be launched from the Pacific Missile Range into polar orbit. The current research and development program consists of [deleted] vehicles. During the research and development phase, maximum use of the Discoverer tracking and acquisition stations is made. The stations will be modified with the specialized equipment needed to perform the [deleted] function for the Samos payloads. Additional stations are planned [deleted] for location in New Hampshire, Iowa, and Oregon.

MIDAS (MISSILE DEFENSE ALARM SATELLITE PROJECT)

(*e*) *Midas objective.*—The research and development project is directed toward the development of the capability to provide continuous screening of worldwide launchings of ballistic missiles through the detection of infrared emanations from the associated exhaust plume during powered ascent of the missile(s). In this manner, through instantaneous reporting by the satellite to a ground station which relays data to the appropriate operational forces, maximum warning data can be obtained regarding a hostile missile attack. [Deleted.]

(*f*) *Midas program.*—The Midas system also makes maximum use of developments from the Discoverer project and will use the Agena vehicle boosted by Atlas missiles. During the research and development phase it will also use the Discoverer tracking and acquisition stations augmented by an additional Midas readout station in Alaska. The research and development project consists of [deleted] vehicles, the first two of which are to be launched from the Atlantic Missile Range into low inclination equatorial orbits and the remainder are to be launched from the Pacific Missile Range into polar orbits. The first Midas launched out of the Atlantic Missile Range on February 26, 1960, failed to go into orbit. Preliminary analyses of the telemetered data indicate that the failure which occurred at separation of the Atlas and Agena stages was due to an explosion of the Atlas retrorockets resulting in damage to the rear end of the Agena vehicle. Analyses and tests are continuing, so that engineering modifications can be made as necessary to Midas No. 2, which is scheduled for launching in April. The Midas operational system as proposed, consists of a system of [deleted] satellites in [deleted] polar orbits at an altitude of 2,000 nautical miles. As the satellites circle the earth, the infrared payload will detect ICBM's launched from Soviet territory. Because instantaneous warning [deleted] with the satellites orbiting over Russia, the operational system will require [deleted] and Alaska. The communications network from the readout stations to the appropriate operational forces will be integrated with the ballistic missile early warning system communications lines to the maximum extent possible. In addition, the operational Midas system will use the Samos tracking and acquisition stations for appropriate command control of the vehicles.

g. Funding history—President's budget

	Prior years	Fiscal year 1960	Fiscal year 1961
Discoverer	(1)	(1)	(1)
Samos	(1)	(1)	(1)
Midas	(1)	(1)	(1)
Total	$356.7	$298.9	$333.0

[1] Breakdown deleted.

(*h*) Current project reviews indicate the desirability of incorporating some technical and funding adjustments. These adjustments are in process, however definitive funding changes cannot be determined until reprograming has been finalized and contract negotiations undertaken.

In this regard, the Discoverer, Samos and Midas research and development projects must be treated as a unit because they are so integrally related. The projects have different objectives and different primary payloads. However, all three projects have in common the same prime contractor, many of the subcontractors, the Agena satellite vehicle facilities and tracking stations, and many secondary subsystems. As a result, programing and funding adjustments in one project have direct effects on the costing for the others.

Planned changes involve an extension to the Discoverer project, a considerable expansion of the rate of effort being applied to Midas and some decrease in the rate of effort being applied toward certain aspects of [deleted] Samos. The revised program will be supported by reallocation of funds among the Discoverer, Samos and Midas projects and by utilization of funds which can be reallocated as the result of changes in the Air Force air defense programs. We will inform you of the revised programs and level of effort as soon as the details become available.

5. DYNASOAR PROJECT

(*a*) *Objective.*—The research and development project is directed toward the development of a military test system which will explore and solve problems of hypersonic flight including controlled manned return from near orbital velocities. Solution of these problems will contribute toward possible manned military operations in space.

(*b*) *Program.*—The Dynasoar flight vehicle will consist of a large, multi-stage rocket which will boost a manned test vehicle to near orbital velocity. The test vehicle will have global range, will be able to maneuver in the atmosphere and to return for a normal landing at a military base. The Dynasoar project is in three steps. Step one is planned for full-scale unmanned gliders to be boosted by a Titan ICBM to speeds up to [deleted] feet per second. Manned gliders will then be boosted by Titans to [deleted] feet per second. Step two will require larger boosters not yet defined and will include determinations of military uses of such a system. Step three will include studies of weapon systems growing out of the Dynasoar development. At this point, step one only has been authorized on a limited basis to include a reexamination of the technical approach toward achieving program objectives to insure the best and most economical approach prior to proceeding with development. Current planning is directed toward the first unmanned ground launch in [deleted].

c. Funding history (in millions)

Dynasoar:	
Prior years	$32.5
Fiscal year 1960	35.0
Fiscal year 1961	58.0

6. X–15 RESEARCH AIRPLANE PROJECT

(*a*) *Objective.*—The objective of the X–15 research airplane project is to collect full-scale free-flight data to validate advanced theory, analytical methods and wind tunnel methods that have been developed to enable the design of vehicles which will operate at hypersonic speeds and at extreme altitudes within the atmosphere during all or a portion of their flight. In this category are included such topics as stability and control, hypersonic lift and drag, aerodynamic heating and dynamic and thermodynamic structural effects at speeds up to mach 6.5 and altitudes in excess of 250,000 feet and during recovery and landing from flights attaining this level of performance. As a byproduct of achieving this basic research capability, the X–15 provides an opportunity to study the human operator in a space equivalent environment during the ballistic and reentry phases of flight.

(*b*) *Program.*—The X–15 project is a joint Air Force-Navy-National Aeronautics and Space Administration effort. The Air Force has management responsibility for development and the National Aeronautics and Space Administration has the responsibility for technical direction. The program provides for three research airplanes which have been delivered to Edwards Air Force Base, Calif., for flight test. During flights with the No. 1 and No. 2 X–15's launched from B–52's, the following milestones have been achieved:

(1) March 10, 1959—First captive flight.
(2) June 8, 1959—First glide flight.
(3) July 24, 1959—Fueled captive flight.
(4) September 17, 1959—First powered flight.
(5) October 1959—Second powered flight.
(6) November 1959—Third powered flight.
(7) January 1960—Fourth powered flight.
(8) Maximum performance: M–2.3 and 65,000 feet.

The No. 2 airplane was damaged during an emergency landing following an explosion in the XLR–11 rocket engine during the third powered flight on November 5, 1959. The airplane has been repaired and flight testing has been resumed. Investigation into the cause of the explosion has resulted in revisions to the engine ignition system to prevent interruption of the ignition cycle which is suspected of having caused the explosion.

As flight tests have been proceeding with the No. 1 and No. 2 airplanes and pending the availability of the desired XLR–99 engine, a low level of effort has been devoted to preparing the No. 3 airplane for the XLR–99 engine installation. Preliminary flight rating tests of the XLR–99 engine were completed in

January 1960. Target date for powered flight with the XLR–99 engine is April 1960.

The X–15 flight operations have been disrupted during the latter part of December and January due to the existence of water on Rogers Dry Lake at Edwards Air Force Base. Stand-by plans have been made to shift the X–15 landing site to an alternate dry lake in the event this situation should arise again.

c. Funding history

[In millions]

X–15:	
Prior years	$107.3
Fiscal years 1960	27.7
Fiscal year 1961	6.0

7. MISSILE RANGES

The three inclosures, data sheets, provide descriptive and financial data for the three National Missile Ranges, all of which support the space projects to a varying and limited extent.

These ranges were established and developed over the years primarily to support the military guided missile programs (including ballistic missiles). Assets and technical capability are a combination of "inherted plant" from predecessor activities, conversion of much surplus military equipment, especially radars, to range use, new construction and equipment and finally project equipment turned over to the ranges for their further use upon project completion. Dollar value of plant should, therefore, be considered as "educated estimates."

"Space program" support still represents a minor, but fast-growing, part of the workload at the ranges. The Atlantic Missile Range has become a major launch site for large space probes and orbital vehicles. It will be utilized for the launch and planned recovery of Mercury vehicles. The Pacific Missile Range provides support to Air Force polar satellite launchings from Vandenberg Air Force Base and later from Air Force pads on the Pacific Missile Range Point Arguello activity. In addition, the Pacific Missile Range is assisting in Discoverer tracking and recovery and in the tracking, recovery, and communication support of the Mercury project. The White Sands Missile Range began its space program participation in 1946 as the site for V–2 rocket "probes" and continues this probe work, now supporting Aerobee launchings.

It is expected that the national missile ranges will have an increasing role in support of the growing U.S. space program.

There are in addition, of course, many broad space related studies and some component developments which are relatively minor in nature and have not, therefore, been included in these statements. However, they are included in the fiscal year 1961 budget justifications which have already been forwarded to you.

I hope this material will be of assistance to you in your current deliberations.

Sincerely yours,

JAMES H. DOUGLAS, *Acting.*

ATLANTIC MISSILE RANGE (EXECUTIVE AGENCY, AIR FORCE)

The Atlantic Missile Range was developed from a small nucleus which, during World War II, was a naval training station. It was initially financed by special acts of Congress. The main base at Patrick is supported administratively, operationally, and logistically by the Air Force. The facilities at Cape Canaveral and the 12 downrange stations are operated under Air Force contract by the Pan American World Airways Guided Missiles Range Division and by RCA, the major technical subcontractor. The contractors are, in all aspects of their operations, under the direct control of the Commanding General, AMR/AFMTC. In addition to these operating contractors, there are numerous program contractors who maintain personnel at the base incident to test work. The whole range complex (Patrick, Canaveral, and downrange stations) is designated by the Air Force as the Air Force Missile Test Center, under the Air Research and Development Command. ARDC exercises policy, program, management, and support control directly over AMR. The AFMTC organization includes directors of Army and Navy missile tests, and a representative for those tests under NASA.

Air Force launch facilities at AMR include 26 pads (10 IRBM, 8 AERO, 8 ICBM), 13 blockhouses and a central control building. In addition, the Navy operates a substantial installation (valued at $27 million as of June 30, 1959) for Polaris testing at Cape Canaveral, and the Army's Missile Firing Laboratory there represents about a $25 million investment. The total plant value of AMR carried on Air Force books is approximately $360 million; when project equipment and other service investment is added the total investment is estimated at $515 million as of June 30, 1959. Generally, AMR's mission is to provide facilities and range support for research and development testing and evaluation of medium- and long-range ballistic and aerodynamic missiles, and training firings of medium-range aerodynamic missiles, as well as satellite projects. AMR's range is presently instrumented to a distance of 5,500 nautical miles.

	1959, actual	Fiscal year 1960, estimate	Fiscal year 1961, estimate
Personnel (number end of year):			
Military	1,882	1,859	1,813
Government civilian	1,908	1,939	1,915
Contractor	8,216	8,819	8,819
Total	12,006	12,617	12,547
Investment (Air Force, in millions):			
Land	$9.3		
Buildings	183.9		
Equipment	166.6		
Total	359.8	(1)	(1)
Funding (in millions):			
Research, development, test, and evaluation	105.7	$120.1	$120.1
Operation and maintenance	.6	.6	.7
Military construction	19.3	3.5	5.9
Other agencies	7.8	5.8	6.5
Total funding	133.4	130.0	133.2

[1] Air Force has not estimated investment for fiscal years 1960 and 1961.

NOTE.—The data above and those on other national missile ranges has been compiled on a different basis, and in some respects includes later information than is listed for the ranges in the research, development, test, and evaluation installation sheets.

PACIFIC MISSILE RANGE (EXECUTIVE AGENCY, NAVY)

The Pacific Missile Range (PMR) was established in 1958. PMR is an interlocked complex of four separate ranges—the Seat Test Range (250 miles by 500 miles) using bases at Point Mugu, San Nicholas Island, San Clements, and Point Arguello (naval missile facility), the Ballistic Missile Range (extending 5,000 miles into the Pacific and used for firings from Vandenberg AFB), the Polar Satellite Range (south from Point Arguello), and the Antimissile Range.

The commander, PMR, in addition to a Navy deputy commander, has deputy commanders from the Army and Air Force, and will get a representative from NASA as well. Management control of PMR is exercised directly by the Bureau of Naval Weapons, policy control by the Office of CNO and the Under Secretary of the Navy, and program control by Office of Secretary of Defense. PMR uses the contracted services of Land-Air, Inc., Federal Telecommunications, and Bendix Aviation for certain technical range operations and development effort.

Launch facilities at PMR, in addition to those under construction at Point Arguello are located at Point Mugu. The total plant value of PMR at the end of fiscal year 1960 will be approximately $130 million. The PMR's mission is to provide range support for DOD and other designated Government agencies for launching, tracking, and collecting data in missile satellite and space vehicle research, development, evaluation on training programs, and actual operations.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Personnel (average numbers):			
Military	2,491	3,110	3,110
Civil service	2,887	3,303	3,441
Contractor (includes project personnel)	2,017	3,578	4,172
Total	7,395	9,991	10,723
Investment (millions of dollars):			
Land	$2.7	$2.7	$2.7
Buildings	46.4	74.9	89.0
Equipment	41.7	53.3	84.0
Total	90.8	130.9	175.7
Funding, Navy appropriations (millions of dollars):			
Research, development, test, and evaluation	60.4	80.6	68.8
Other procurement	2.3	3.8	4.0
Operation and maintenance	2.2	2.7	3.0
Shipbuilding and conversion		10.0	
Military construction	14.0	25.8	5.0
Total, Navy	78.9	122.9	80.8

White Sands Missile Range (Executive Agency, Army)

White Sands Missile Range was established in 1952 by integrating White Sands Proving Ground, the Alamogordo Bombing Range, and certain facilities of Holloman Air Force Base. All three services have organizations on the range, the Army Missile Test Center, the Naval Ordnance Missile Test Facility, and the Air Force Missile Development Center at Holloman Air Force Base. White Sands Missile Range provides a maximum range of approximately 87 nautical miles. However, 20 days a year the range will be extended 40 miles on a rental basis for Nike-Zeus firings. The commanding general, White Sands Missile Range, who reports to the Army Ordnance Missile Command, has two range deputies, the commanders of the NOMTF and AFMDC. Principal support for White Sands Missile Range in administration, logistics, workload, facilities, personnel, equipment, and funding comes from AOMC. White Sands Missile Range utilizes two contractors, Land-Air, Inc., and Telecomputing Corp., to provide part of the data collection and data reduction service to the range.

Launch facilities at White Sands Missile Range are valued at $5,795,000. The launch facilities include 20 pads, 5 blockhouses, and 12 central control facilities. The total plant value of WSMR is $234 million.

Generally, White Sands Missile Range's mission is to provide facilities and range support for research and development, testing and evaluation of short and medium range surface-to-surface, air-to-air, surface-to-air, air-to-surface missiles, and early research and development portions of larger range systems. In 1959, about 58 percent of the live firings were by the Army, 2 percent by the Navy, and 40 percent by the Air Force.

	Fiscal year 1959, actual	Fiscal year 1960, estimate	Fiscal year 1961, estimate
Personnel (number end of year):			
Military (including project personnel)	4,395	4,285	4,300
Government, civilian	4,630	4,700	4,900
Contractor (includes project personnel)	1,550	1,450	1,450
Total	10,575	10,435	10,650
Investment (millions of dollars):			
Land	$12.7	$12.7	$12.7
Buildings	46.7	52.0	57.0
Equipment	151.6	155.6	160.6
Utilities	13.0	14.0	14.0
Total	224.0	234.3	244.3
Funding (including project funds support) (in millions of dollars):			
Research, development, test, and evaluation	58.1	70.3	82.0
Procurement of equipment and missiles, Army	16.7	1.6	3.0
Operation and maintenance, Army	1.2	1.6	2.0
Military construction	16.5	5.4	4.9
Other agencies	.2	.4	1.8
Total funding	92.7	79.3	93.7

NOTE.—The above includes the White Sands Signal Corps Agency.

(The following budget justification material was submitted to the committee by the Department of Defense on March 8, 1960:)

DEPARTMENT OF THE AIR FORCE JUSTIFICATION OF ESTIMATES FOR FISCAL YEAR 1961

Missile procurement, Air Force ballistic missiles, fiscal year 1961

	Estimate[1] *(in millions)*
SM–65, Atlas	$974.9
SM–68, Titan	788.0
SM–80, Minuteman	368.3
Space	60.0
Dynasoar boosters	8.0
General support	51.1
Total	2,250.3

[1] Details have been deleted for security reasons.

Research, development, test and evaluation—military astronautics and related equipment

Program requirements:

Fiscal year 1961	$261,846,000
Fiscal year 1960	278,879,000
Fiscal year 1959	264,131,000

PART I. PURPOSE AND SCOPE

This program provides for research, development, test, and evaluation of military astronautics systems and related equipment as identified with the Air Force mission, including integral components and equipment identifiable with military astronautics equipment, and ground support equipment related to military astronautics equipment.

PART II. JUSTIFICATION OF FUNDS REQUESTED

The following tabulation reflects the comparison of fiscal year 1960 and fiscal year 1961 estimates by program structure:

	Fiscal year 1960 estimate	Fiscal year 1961 estimate
Strategic systems	$160,000,000	$199,900,000
Air defense systems	31,300,000	41,000,000
Advanced development program	83,950,000	15,100,000
Applied research	3,629,000	5,846,000
Total	278,879,000	261,846,000

Explanation of the composition of major areas follows:

The strategic systems area is comprised of the Samos space system.

The funds included in the Samos program provide for the development of a reconnaissance capability utilizing polar orbiting satellites. [Deleted] payloads will be developed for the satellites, [deleted]. The intelligence so gathered will be used within the military community for national defense purposes.

The air defense systems area is comprised of the Midas space system.

The funds included in the Midas program provide for the development of a missile defense alarm system which will space a series of reconnaissance satellites in orbit around the earth. The payload will consist of infrared detection scanners capable of [deleted].

The advanced development program is comprised of the Discoverer project. The funds included in this program provide for the development of orbital capability and to obtain biomedical and advanced engineering test data from the recoverable payload capsules.

All funds in the applied research program will be used in three areas:

Advanced weapons.—For investigation of directed energy weapons, lenticular rockets, hypervelocity weapons and impact studies;

Propulsion.—To be used on the space propulsion engine study; and,

Flight vehicle power.—Which includes thermal energy conversion research and solar secondary power.

DEPARTMENT OF THE NAVY

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, NAVY

Budget activity B—Bureau of Naval Weapons—Project 4B: Military astronautics and related equipment

1961 estimate	$1,272,000
1960 estimate	----------
1959 actual	----------

PURPOSE AND SCOPE OF WORK

This project provides for research, development, test, and evaluation necessary to determine the feasibility of unmanned or manned space satellites, and satellite reconnaissance countermeasures to support basic naval missions.

EXPLANATION OF FUNDS REQUESTED

The Bureau of Naval Weapons effort in military astronautics is designed to fulfill requirements outlined in the fiscal year 1961 Chief of Naval Operations guidelines. This effort will be concentrated in four areas: 1. Advanced space technology, 2. Satellite applications, 3. Satellite reconnaissance countermeasures research, and 4. Satellite navigation. These four areas will encompass the following:

Advanced space technology [Deleted].—This project will provide for theoretical studies, laboratory tests, and field experiments involving breadboard and experimental models of proposed space vehicle systems, subsystems and components. Theoretical studies of an air-launched vehicle have been conducted by Bureau personnel under the sponsorship and funding of the Advanced Research Projects Agency.

Satellite applications [Deleted].—Requested funds will permit the determination of system performance parameters in terms of military requirements and the conduct of applied research and development programs necessary to produce a family of unmanned satellites. Initial emphasis will be given to the maximum utilization of existing and presently planned flight vehicles and the utilization of existing shelf components to provide early capability.

Satellite reconnaissance countermeasures research [Deleted].—This project will provide a theoretical and experimental program to determine the nature of the threat of satellite reconnaissance to sea forces and to determine the feasibility of active and passive countermeasures to mitigate the threat.

Satellite navigation [*Deleted*].—Efforts in this program (Project Transit) will provide a worldwide passive navigational system for use by surface ships, submarines, and aircraft. The feasibility of a navigational system using satellites will be demonstrated by Bureau personnel under sponsorship and funding by the Advanced Research Projects Agency. Requested funds will provide for initiation of the design and development of an operational navigational satellite system.

Standard Form 3a
(Approved by President June 14, 1955 Revised October 31, 1957)

Appropriation title:
(U. 180 C. & I. e. Bank)

DEPARTMENT OF DEFENSE
SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY

Program and Financing

	FY 59 actual	FY 60 estimate	FY 61 estimate
Program by activities:			
Direct obligations			
1. Military sciences	$ 46,632,193	$132,340,000	$144,000,000
4. Military astronautics and related equipment	103,068,549	111,913,744	67,000,000
8. Programwide management and support	3,170,546	4,000,000	4,000,000
Total direct obligations	152,871,288	248,253,744	215,000,000
Reimbursable obligations:			
4. Military astronautics and related equipment	1,997,000	.....	.....
Total obligations	154,868,288	248,253,744	215,000,000
Financing:			
Comparative transfers to other accounts	238,161,744	113,246,256	.....
Unobligated balance brought forward	-67,583,806	-112,145,560	-39,795,560
Unobligated balance transferred to "Research, development, test and evaluation, Air Force" (73 Stat. 377)	.....	19,000,000	.....
Unobligated balance transferred from -			
"Research, development, test and evaluation, Air Force" (72 Stat. 712)	-170,000	.....	.....
"Emergency fund, Department of Defense" (73 Stat. 377)	.....	-15,000,000	.....
Advances and reimbursements from other accounts	-1,997,000	.....	.....
Unobligated balance carried forward	112,145,560	39,795,560	39,795,560
New obligational authority	435,424,786	293,150,000	215,000,000

Standard Form 1a (Approved by President June 16, 1959 Revised October 31, 1947)

Appropriation title: (U. S. C. 31 a. Supp.)

DEPARTMENT OF DEFENSE
SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY

Program and Financing

	1959 actual	1960 estimate	1961 estimate
New obligational authority:			
Appropriation	$520,000,000	$455,000,000	$215,000,000
Transferred from -			
Aircraft, missiles, and related procurement (Air Force)(72 Stat. 712)	8,500,000	.....	.....
"Emergency fund, Department of Defense" (72 Stat. 713; 73 Stat. 377)	51,900,000	19,400,000	.....
"Missile procurement, Air Force" (73 Stat. 377)	.....	75,000,000	.....
Transferred to -			
"Military construction, Advanced Research Projects Agency, Department of Defense" (72 Stat. 1096)	-28,065,214	.....	.....
"Procurement of equipment and missiles, Army" (72 Stat. 712)	-2,210,000	.....	.....
"Research, development, test and evaluation, Army" (72 Stat. 712)	-15,500,000	.....	.....
"Research and development National Aeronautics and Space Admin tration"(72 Stat. 433)	-59,200,000	.....	.....
"Research, development, test and evaluation, Air Force" (73 Stat. 377)	.....	-256,250,000	.....
Appropriation (adjusted)	435,424,786	293,150,000	215,000,000

Standard Form 36
(Approved by President
June 16, 1950
Revised October 31, 1951)

Appropriation title:
(U. S. C. 31 & Supp.)

DEPARTMENT OF DEFENSE
SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY

Object Classification

	1959 actual	1960 estimate	1961 estimate
Total number of permanent positions	44	70	67
Full-time equivalent of all other positions	1	2	2
Average number of all employees	30	62	68
Number of employees at end of year	46	69	69
Average GS grade and salary	8.3 $6,968	9.3 $7,772	9.3 $7,852
Direct obligations:			
01 Personal services:			
Permanent positions	$232,055	$523,410	$582,635
Positions other than permanent	13,793	26,000	26,000
Other personal services	4,284	10,590	8,365
Total personal services	250,132	560,000	617,000
02 Travel	41,219	90,000	90,000
03 Transportation of things	2,383	12,000	12,000
04 Communication services	20,219	25,000	30,000
06 Printing and reproduction	4,296	20,000	20,000
07 Other contractual services	152,478,036	247,465,744	214,162,000
08 Supplies and materials	4,462	9,000	9,000
09 Equipment	55,217	354000	20,000

Standard Form 36
(Approved by President
June 14, 1955
Revised October 30, 1957)

Appropriation title:
(U. S. C. 31 a. Sub)

DEPARTMENT OF DEFENSE
SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY

Object Classification

	1959 actual	1960 estimate	1961 estimate
Direct obligations - continued			
11 Grants, subsidies and contributions	$15,046	$35,500	$38,500
13 Refunds awards and indemnities	.....	1,000	1,000
15 Taxes and assessments	278	500	500
Total direct obligations	152,871,288	248,253,744	215,000,000
Reimbursable obligations:			
07 Other contractual services	1,997,000	.....	.....
Total obligations	154,868,288	248,253,744	215,000,000

DEPARTMENT OF DEFENSE

ADVANCED RESEARCH PROJECTS AGENCY

BUDGET ESTIMATES

FOR

SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY

FISCAL YEAR 1961

GENERAL JUSTIFICATION

1/11/60

53795 O—60—pt. 1——31

DEPARTMENT OF DEFENSE
ADVANCED RESEARCH PROJECTS AGENCY

JUSTIFICATION OF ESTIMATES, FY 1961

APPROPRIATION TITLE: Salaries and Expenses, Advanced Research Projects Agency, Department of Defense

Appropriation Language

Appropriation Introduction

Purpose and Scope of Appropriation

Summary of Program by Category

Explanation of Estimates:
- General
- Ballistic Missile Defense
- Solid Propellant Chemistry
- Materials
- Vela
- Communication Satellites
- Precision Navigation Satellites
- Satellite Tracking and Data Acquisition
- Miscellaneous Projects
- Program-Wide Management and Support

APPROPRIATION LANGUAGE

SALARIES AND EXPENSES, ADVANCED RESEARCH PROJECTS AGENCY, DEPARTMENT OF DEFENSE

For expenses necessary for such advanced research projects as may be designated and determined by the Secretary of Defense, pursuant to law, [$455,000,000] *$215,000,000*, to remain available until expended: *Provided*, That such amounts as may be determined by the Secretary of Defense to have been made available for related programs in other appropriations available to the Department of Defense during the current fiscal year may be transferred to and merged with this appropriation to be available for the same purposes and time period: *Provided further*, That such amounts of this appropriation as may be determined by the Secretary of Defense may be transferred to carry out the purposes of advanced research to those appropriations for military functions under the Department of Defense which are being utilized for related programs, to be merged with and to be available for the same time period as the appropriation to which transferred. (*Department of Defense Appropriation Act, 1960.*)

Appropriated 1960, **$455,000,000** Estimate 1961,* **$215,000,000**
Appropriated (adjusted) 1960, **$293,150,000**

* Excludes $140,000,000 for activities transferred in the estimates to appropriations as follows:

"Salaries and expenses, National Aeronautics and Space Administration"	$34,316,000
"Research and development, National Aeronautics and Space Administration"	92,684,000
"Construction and equipment, National Aeronautics and Space Administration"	13,000,000

The amounts obligated in 1959 and 1960 are shown in the schedule as a part of the comparative transfers.

DEPARTMENT OF DEFENSE
ADVANCED RESEARCH PROJECTS AGENCY

JUSTIFICATION OF ESTIMATES, FY 1961

APPROPRIATION TITLE: Salaries and Expenses, Advanced Research Projects Agency, Department of Defense

Appropriation Introduction

	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
Appropriation or estimate	$ 520,000,000	$ 455,000,000	$ 215,000,000
Adjustments by transfers	-84,575,214	-161,850,000	.....
Advances and Reimbursements from other accounts	1,997,000	.....	.....
Comparative transfers to other accounts	-238,161,744	-113,246,256	.....
Unobligated balance brought forward	67,583,806	112,145,560	39,795,560
Unobligated balance transferred (net)	170,000	-4,000,000	.....
Unobligated balance carried forward	-112,145,560	-39,795,560	-39,795,560
Total obligations	$ 154,868,288	$ 248,253,744	$ 215,000,000

This appropriation provides research and development funds for projects assigned to the Advanced Research Projects Agency. ARPA funds for FY 1961 will support research on ballistic missile defense, solid propellant chemistry, basic research on materials, and research necessary to better understand problems associated with the moratorium on nuclear testing. In addition, the funds will provide for military application of space technology techniques to navigation and communications, and will support related satellite tracking and data acquisition efforts. Work in other areas may also be assigned to ARPA.

areas may also be assigned to ARPA.

PURPOSE AND SCOPE OF THE APPROPRIATION

The current research and development projects of the Advanced Research Projects Agency are concerned with the application of space technology to military problems, with the investigation of improved methods of defense against ballistic missiles, propellant chemistry, and materials research. Work may also be assigned to the Agency in other areas.

1. Military Science. - Projects include missile defense, propellant chemistry, materials research, and Vela.

2. Military Astronautics and Related Equipment. - Projects include military uses of satellites for communications, navigation, and tracking and data readout systems.

3. Program-Wide Management. - Executive and technical management at ARPA headquarters.

SUMMARY OF PROGRAM BY CATEGORY

	ESTIMATED OBLIGATIONS FY 1960	FY 1961
Military Sciences		
1. Ballistic Missile Defense	$106,000,000	$110,000,000
2. Solid Propellant Chemistry	18,000,000	17,000,000
3. Materials	240,000	17,000,000
4. Vela	8,100,000	--
Sub-Total	132,340,000	144,000,000
Astronautics and Related Equipment		
1. Communications	46,000,000	42,000,000
2. Navigation	19,000,000	7,000,000
3. Tracking	17,570,000	18,000,000
4. Miscellaneous Projects	29,343,744	--
Sub-Total	111,913,744	67,000,000
Program-Wide Management and Support	4,000,000	4,000,000
Total	$248,253,744	$215,000,000

Department of Defense
ADVANCED RESEARCH PROJECTS AGENCY

EXPLANATION OF ESTIMATES - FY 1961

Introduction

The programs of the Advanced Research Projects Agency are summarized in the following categories:

Military Sciences - Ballistic Missile Defense; Solid Propellant Chemistry; Materials; Vela

Astronautics and Related Equipment - Military Space Technology

Program-Wide Management and Support - Executive and Technical Direction

These technical programs have been assigned to ARPA by the Secretary of Defense. Budget estimates have been developed to meet necessary national defense goals in these areas.

Program Authority

The Advanced Research Projects Agency was established on February 7, 1958, by Department of Defense Directive 5105.15. This Directive provides that "The agency shall be responsible for the direction or performance of such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by individual project or by category."

That certain research areas would be given special consideration was essentially endorsed by Congress in Section 7, Public Law 85-325, dated February 12, 1958. This legislation, as

amended by the Department of Defense Reorganization Act of 1958, provides "The Secretary of Defense or his designee is authorized to engage in such advanced projects essential to the Defense Department's responsibilities in the field of basic and applied research and development which pertain to weapon systems and military requirements as the Secretary of Defense may determine."

The National Aeronautics and Space Act of 1958 provides, in part, "that activities peculiar to, or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the U. S.) shall be the responsibility of and shall be directed by, the Department of Defense. . ."

ARPA Operations

ARPA was established as a line agency within the Department of Defense, with the Director responsible to the Secretary of Defense. In late 1959, a realignment was effected under which the Director of ARPA is now responsible to the Director, Defense Research and Engineering.

Within program areas assigned by the Director, Defense Research and Engineering, ARPA plans, initiates and directs specific research and development projects. Although authorized by law to do so, ARPA has not built laboratories or facilities of its own. It operates as a small management team which maintains cognizance over its assigned programs by means of budgetary control, management surveillance and technical direction. Assistance in technical matters is provided by the Institute for Defense Analyses. This group, under contract to ARPA, recommends technical projects and is available for consultation on the technical aspects of ARPA programs.

During 1959, decisions were made to transfer from ARPA's cognizance a number of Military Space Technology projects. DISCOVERER, SAMOS, and MIDAS have been transferred to the Air Force. The SATURN project will be transferred to the National Aeronautics and Space Administration upon Congressional approval of the "SATURN team's" transfer to NASA. In the interim, close coordination in the technical aspects of SATURN has been effected by the ARPA and NASA staffs.

	FY 1960	FY 1961
BALLISTIC MISSILE DEFENSE - Project Defender	$106,000,000	$110,000,000

To meet the threat of enemy operational ballistic missiles, this country must have active ballistic missile defense systems. Within the conventional concepts of active defense, the development of the NIKE-ZEUS system of terminal defense has brought us to the practicable limit of our technical sophistication. The enemy threat, however, is of such a nature that conventional concepts are totally inadequate to cope with it.

The development of advanced active ballistic missile defense systems is one of the most vital considerations facing this country. It also presents one of the most challenging technical problems with which our scientists and engineers must contend. The basic features of the problem are that missiles and re-entry warheads:

Have extremely high velocity - allowing very short reaction times;
Are compact and smooth - making detection difficult;
Are extremely durable - making destruction difficult.

To develop techniques for valid, reliable detection and identification of enemy ballistic missiles, further advances must be made in our knowledge of radar, infrared and optical systems. The development of these techniques will be enhanced by our attaining a better understanding of both the natural and disturbed conditions of the upper atmosphere and the space medium.

The alternative methods of missile interception, i.e., early, midcourse and terminal intercept, must be studied and carefully evaluated in their relation to the other aspects of the system. Techniques for destroying the intercepted missile or re-entry warhead are being examined and evaluated. These "kill mechanisms" must be highly effective in order to destroy a missile nose cone which is capable of surviving re-entry into the atmosphere.

An integral part of the defense system is a capability to receive and process the voluminous amounts of data gathered by the system's sensing elements. These data must be analyzed and communicated at ultra-high speeds, with no margin for error.

The goal of the ARPA ballistic missile defense program is to provide the country with advanced ballistic missile defense systems which are technically, operationally, and economically feasible. These, together with our deterrent capability and our means of passive defense, will improve immeasurably the country's defense posture.

	FY 1960	FY 1961
Defender - Exploratory Investigations	$ 11,000,000	$ 11,000,000

The objective of this program is, through analysis and experimentation, to investigate new possible defense system concepts, new techniques and basic information which will provide the urgently needed answers to missile defense problems and lead to the design of a defensive system which will be effective against a broad spectrum of missile threats.

Ballistic missile technology currently provides the offense with significant advantage. Thus, new and novel methods of defense against ballistic missiles must be evolved continuously if they are to be effective.

The FY 1961 program continues the quest for new defense system concepts, techniques, and basic information. The program is broken down into two broad areas. Defense complex studies include work on the nature and influence of the missile threat variables, evaluation of mixed system cost effectiveness, strategic threat studies and war gaming studies. It also is designed to promote information exchange between workers in the various fields related to ballistic missile defense as a means of stimulating cross fertilization of ideas. Related subsystem studies and development are also conducted.

	FY 1960	FY 1961
Defender - Physics	$ 10,000,000	$ 10,000,000

It is believed that a better knowledge of atmospheric physics might assist in designing techniques for improved detection, discrimination, and kill of ballistic missiles at various points along their trajectory. Other fields of study include rocket exhaust physics, the physics of re-entry phenomena, and physics of high altitude chemical releases.

All phases of ballistic missile defense take place within an atmospheric medium as measurable densities of atmospheric constituents extend into interplanetary space. Research in this major unknown area of missile defense, as well as in the interactions between the atmosphere and solid bodies traveling at high velocities, requires continued and expanded effort since the nature of even the undisturbed atmosphere is poorly understood.

The work under way in this field ranges from basic physics studies of atomic cross-sections and molecular interactions to probable launchings, and the use of a special ionospheric radar to study electron density. The release of chemicals at high altitude and study of artificial electron clouds and luminescence will also provide basic data useful to better understanding the medium in which weapons systems must operate.

During the past year, work on radar blackout has resulted in a decision to increase radar frequencies for terminal units, and work on re-entry phenomena has indicated possible techniques of discrimination.

	FY 1960	FY 1961
Defender - Data Processing	$ 2,000,000	$ 2,000,000

This deals in general with research relating to the data network required for coordination of the defenses against ballistic missiles, the doctrines of target evaluation and weapon assignment, the place of the human in an automatic missile defense system, and to the study of general data processing techniques aimed at the discrimination problem.

Immediate and long-term missile defense system effectiveness will be dependent upon vast quantities of information gathered by diverse sensing elements in the missile defense complex. Voluminous amounts of data must be handled at ultra-high speeds with unerring accuracy and efficiency. Results of the analysis of the data from the input sensing devices must be communicated to a target evaluation and weapon assignment center. These will provide the input information for launching of the interceptor with or without human intervention.

Work is under way to define, in engineering terms, the types of network problems that must be solved, and to develop computer techniques of weapons assignment as related to the decoy and discrimination problem.

The work accomplished under this program includes: the development of concepts for processing multistatic radar information; development of small, high capacity processing techniques using acoustic distortion to modulate light beams in refractive media; development of extremely high capacity, high speed storage devices.

extremely high capacity, high speed storage devices.

	FY 1960	FY 1961
Defender - Discrimination	$ 4,000,000	$ 4,000,000

Conventional defense systems, i.e., those employing radar and anti-missile missiles, can be built to give a high probability of kill if the attack consists, within their zone of action, of a small number of identified warhead-containing re-entry bodies. However, ballistic missiles deliver payload or tonnage which can be divided in a variety of ways. If the defense system is anticipated to be highly effective against a simple form of attack, the offense can trade yield for countermeasures, such as decoys and jammers, to take advantage of the natural weaknesses of defense systems and reduce the defense effectiveness. The offense's purpose, of course, is to maximize the yield (or desired effect) on target either by saturating, confusing or avoiding the defense system.

It is the objective of the discrimination program to perform research which will lead to the successful attainment of a counter-countermeasure capability. To this end, it is necessary to gather pertinent data on warhead and decoy characteristics and to investigate a wide spectrum of potential discrimination techniques.

In view of the potential versatility of the threat, a prime objective of defense design is to make the ballistic missile attack in strategic war as expensive and uncertain as possible, at the least cost to the defense.

Research leading to a capability to discriminate between warhead and decoys will be continued during FY 1961.

Accomplishments under the discrimination program include the development of a better understanding of capabilities and limitations of various discrimination techniques. This has resulted in the discontinuance of some techniques and the placing of increasing emphasis on others.

	FY 1960	FY 1961
Defender - Interception	$ 2,000,000	$ 2,000,000

The interception program is concerned with advanced experimental and theoretical techniques to be utilized in the design of hypersonic vehicles, capable of intercepting ballistic missiles or satellites at long-range outside the atmosphere.

The interception task is concerned with all design and development problem areas pertaining directly to the interceptor vehicle from the time it is launched from its platform, whether ground based, airborne, or space based, until it successfully delivers its payload to the vicinity of the offensive weapon.

The primary accomplishment in FY 1959 in the field of aerodynamics was the design and initiation of construction of a hypersonic tunnel which is critically needed for duplicating actual flight conditions.

In the propulsion field, a low-inertia means of varying the thrust vector for highly maneuverable exo-atmospheric interception will be required.

General studies of guidance and control features will be continued in FY 1961.

Defender - Kill Mechanisms	$ 6,000,000	$ 9,000,000

A ballistic missile nose cone, capable of surviving re-entry into the atmosphere, is difficult to destroy by the means now at our disposal. The objective of this portion of the program is to support a vigorous research effort designed to define more closely the kill capabilities of the mechanisms now relied on for destruction, and to discover techniques of greater effectiveness.

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Defender - Kill Mechanisms (Cont'd)

Satellites, because of the instrumentation required to carry out their function, may be susceptible to kill by means that will be ineffective against ballistic missile warheads. These special weaknesses must be investigated.

Once the object to be destroyed has been identified, its destruction may still constitute a serious problem. Because it may re-enter the atmosphere and because it generally needs no wings nor similar weak structure, the warhead re-entry body of a ballistic missile is extremely durable and can be destroyed only by extreme measures. Satellites are not likely to be quite so durable unless they are designated for re-entry. On the other hand, the interception of satellites presents other difficulties such as their greater height.

This program will continue to support research designed to define the kill potential of existing kill mechanisms. The major emphasis, however, will be on investigating, analyzing, and devising new methods of destroying ballistic missiles.

	FY 1960	FY 1961
Defender - Missile Range Measurements	$ 46,000,000	$ 57,000,000

There are many physical phenomena associated with missile launch, flight and re-entry such as visual radiation, infrared and ionization that are not well enough understood or measured to permit prediction from present knowledge, nor can they be adequately simulated in the laboratory for experimental purposes. It is necessary to go to the site of the missile test programs to get actual flight measurements. This program of range instrumentation is now in being at the Atlantic Missile Range, and other instrumentation is being procured for use on the Pacific Missile Range.

Current instrumentation covers the optical, infrared, and radar frequencies at the Atlantic Missile Range. The instruments are shipborne on the ACANIA and AMERICAN MARINER, airborne infrared is used, and ground based data are supplied by many sources.

Defender - Missile Range Measurements (Cont'd)

A radar installation is being planned for Kwajalein to take advantage of flights in the Pacific. The radars to be installed in the Pacific will emphasize the collection of midcourse data and, together with the Atlantic Missile Range information, when analyzed, may provide keys to solving the detection, discrimination, tracking, and intercept problems. The increase in 1961 is for installation of the Kwajalein equipment and its operation.

	FY 1960	FY 1961
Defender - Radar	$ 25,000,000	$ 15,000,000

The radar program objective is to conduct a vigorous research program to advance the state of the art in the radar components and sub-systems necessary to develop long-range, high capacity, high resolution radars that are significantly beyond the capability of those that exist today. Construction of radars of this type will provide radar technique development as well as instrumentation for ballistic missile measurements in the upper atmosphere and for experiments of identification and discrimination.

Considerable improvement is required in the tools by which targets are acquired and tracked. In order to reach out as far as possible into the midcourse flight of a ballistic missile, much greater range capability, higher resolution and capacity for handling enormous amounts of data are needed. It should be emphasized that, although expensive, radars are the only currently available, well understood tool that probably will be used in a sophisticated ground based defensive system. Limited range and resolution are the major short-comings.

The program for advancing radar technology encompasses development of more powerful equipment for range measurement purposes and technique demonstration, applied research in new radar implementation methods, and both basic research and exploratory development on components for ballistic missile defense radars. A large radar is being developed in 1960, and the decrease in 1961 reflects the non-recurrence of this item.

1961 reflects the non-recurrence of this item.

Defender - Radar (Cont'd)

In the radar program these significant accomplishments have been attained: Initiation of development of high frequency multiple-beam radar (PINCUSHION); continuation of development of a multi-element, electronically scanned radar (ESAR); continuation of multi-static radar development (ORDIR); initiation of development of a super-power microwave tube; continuation of research in high power components, radar receiving techniques, signal processing techniques and others.

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	FY 1960	FY 1961
SOLID PROPELLANT CHEMISTRY	$ 18,000,000	$ 17,000,000

Solid propellants have been developed intensively for military applications because of their instant readiness and reliability. Propellants now in use are at least one-third more powerful than those used 15 years ago. However, this development has been based largely on existing chemical and explosives technology, and has gone almost as far as it can. It appears that a further large improvement will require a new chemical breakthrough. The aim of the ARPA project is to provide this breakthrough. The goal is a solid propellant with at least 10 percent higher specific impulse than any now under development.

Two-thirds of the program funds are directed to the synthesis of new, potentially powerful materials which have never been made before, and testing them in small-scale engines. More than 20 laboratories are engaged in this work. Important advances have been made in the first year of the program, particularly in the synthesis of promising new compounds of fluorine. It is anticipated that by Calendar Year 1961 some of the more promising research programs can provide sufficient quantities for intensive propellant development and small-scale motor firing tests.

The remaining one-third of the program funds is in supporting research involving about 30 laboratories. This supporting work is necessary for the efficient development and the effective utilization of the new chemicals as they become available.

	FY 1960	FY 1961
MATERIALS RESEARCH	$ 240,000	$ 17,000,000

The objective of the materials program is to strengthen substantially United States basic research in the field of materials.

The chemical and physical properties of materials now in use constitute major limiting factors in the performance of most weapons systems of importance to the Department of Defense. Currently, materials research is being carried out on an emergency basis as an adjunct to weapons systems development. The over-all effectiveness of the Department of Defense research and development program should improve as the results of this basic materials program become available.

The evolution of new weapons systems invariably creates requirements for new, improved or unusual materials to function in severe operating environments. The solution to these complex materials problems is seldom discovered through the efforts of a single scientific discipline, but is often provided through the joint efforts of a team embracing several scientific disciplines. This materials program will foster the team approach, in the most favorable surroundings, through the support of inter-disciplinary laboratories for basic research in materials at selected universities. The principal scientific disciplines which will be brought to bear on the materials problem through these laboratories are solid state physics, inorganic chemistry, high temperature chemistry, metallurgy, metallurgical engineering, and ceramic engineering.

It is planned that this will be a continuing program, having a future annual level about the same as requested for 1961.

VELA	8,100,000	-0-

This project consists of the research and development necessary to better understand problems associated with the moratorium on nuclear testing.

	FY 1960	FY 1961
COMMUNICATION SATELLITES	$ 46,000,000	$ 42,000,000

This project has the objective of providing an assessment of the technical feasibility of reliable communications satellites for use in global command, control and support of military forces.

At the present time, military long-range communications are primarily handled by radio and cable. Cable communications are very reliable but are of limited capacity and require a long time to install. Furthermore, they are susceptible to sabotage or destruction during war-time. The reliability of current radio communications is very limited. Satellites appear to provide large capacity, secure, and highly reliable communication systems.

There are two major types of satellite communications systems, active relays and passive relays. Active satellite systems are those capable of receiving and relaying signals by means of radio equipment within the satellite. Passive relay systems are basically reflectors which are in orbit. To meet military requirements, the ARPA projects concentrate upon active satellites rather than on passive ones.

Within the field, three projects using active relay communications satellites are being pursued:

1. Project COURIER, a delayed, active repeater system;
2. Project STEER, an instantaneous, active repeater for ground-to-air communication with aircraft in the polar regions;
3. Project DECREE, a 24-hour synchronous, real-time, global system.

1. The concept of the delayed repeater, Project COURIER, is to place within a satellite a number of receivers and transmitters with associated tape recorders. As the satellite passes

in orbit over a ground station, it is commanded by the ground station to receive a message being transmitted to it. The message is then stored on the tape recorder within the satellite. At the next ground station, the satellite is interrogated by the ground station and the transmitter in the satellite, upon command, transmits the stored message which it had picked up from the previous location.

This program consists of a series of three launches, each with a back-up, scheduled one year apart. The first launching is scheduled for the second quarter of Calendar Year 1960. Design of the COURIER satellite has been completed and construction of the first model is under way for scheduled completion in February 1960. The ground equipment is under construction and will be installed and tested prior to the scheduled launch date.

2. The second active relay communications satellite project, Project STEER, has the objective of placing a communications package in polar orbit at 5600 miles altitude, with ground stations in the continental United States and aircraft instrumented to receive and transmit through the satellite.

A system of five or six satellites in this polar orbit, properly spaced, could give complete coverage of the Arctic regions from the continental United States. This would enable a message to be beamed by means of a large tracking antenna to the satellite, which would receive it and rebroadcast it to aircraft operating in the polar regions. The aircraft would be able to reply by way of the same route.

Contracts were let during Fiscal Year 1960 for both the satellite vehicle and the communications payload and ground aircraft equipment. Initial launching is scheduled for the second quarter of Calendar Year 1961.

3. Project DECREE provides for the placement of a real-time radio communications relay in a satellite in a 19,000 nautical mile or so-called 24-hour orbit. Satellites in this orbit will remain approximately stationary over one point of the earth. A system of three such satellites over

COMMUNICATION SATELLITES (Cont'd)

the equator would provide complete global coverage between the Arctic and Antarctic Circles, or from approximately 75 degrees N. latitude to 75 degrees S. latitude.

Contracts have been placed with component manufacturers for preliminary studies on reliability of electronic components and for anti-jamming problems associated with this communication system. A system specification has been completed and system parameters have been fixed. A preliminary development system specification has been prepared and contracts will be placed soon for the high powered electronic components and ground electronics required for this system.

In parallel with the real-time active communications satellite projects, a general study of communications satellite concepts will be continued. New research effort and design work will be started on high reliability long-life satellite components, solid state devices for use at microwave frequencies and applications of molecular electronics techniques. Research studies will be conducted on optimum band utilization, anti-jamming, and long-life kilomegacycle tubes.

	FY 1960	FY 1961
PRECISION NAVIGATION SATELLITES	$ 19,000,000	$ 7,000,000

The objective of the precision navigation satellite program (TRANSIT) is to improve for ships and aircraft the present capability for navigation with regard to: (a) the precision of navigation, (b) worldwide coverage, (c) simplicity of mobile navigating equipment, and (d) all-weather capability.

Many critical military operations demand more exact knowledge of location or position than it is possible with current navigation systems. Satellites, by virtue of the stability and

PRECISION NAVIGATION SATELLITES (Cont'd)

predictability of their orbits, indicate great promise as precise global all-weather aids to navigation. By using a radio transmitter at a precisely controlled frequency, they emit a signal by which observing stations (ships, submarines, or aircraft) can determine position to an accuracy of a fraction of a mile.

Under this program, which has been in progress since early Fiscal Year 1959, one satellite launch attempt was made in September 1959. Although orbit was not achieved, data obtained prior to re-entry of the payload confirmed the usefulness of the system. The program for the balance of Fiscal Year 1960 and Fiscal Year 1961 contemplates continuation of the development and test including three launchings of TRANSIT payloads.

	FY 1960	FY 1961
SATELLITE TRACKING AND DATA ACQUISITION	$ 17,570,000	$ 18,000,000

The objectives of the ARPA Space Surveillance Program are as follows:

a. To detect rapidly, track, collect data from, and assess unknown, silent or uncooperative satellites and to maintain a catalogue of all satellites so that new objects in space are immediately identifiable as such.

b. To support the military scientific and development program in space by providing tracking information, data reception, communications and command facilities for both manned and unmanned satellites and to provide tracking data reduction on all known and cooperative satellites.

c. To provide support of the non-military space program of NASA reciprocally with NASA's support of the military program in accordance with DoD commitments to NASA.

SATELLITE TRACKING AND DATA ACQUISITION (Cont'd)

Both the Department of Defense and the NASA have a need, implicit in every space program (1) of knowing precisely where satellites and space probes are at any moment, to relate this information to the data the satellite is receiving, and (2) of receiving this data on the ground for analysis and use. The worldwide nature of this undertaking, as well as the peculiar requirements of specific projects, requires an extensive investment in stations and equipment and has resulted in a cooperative effort by DoD and NASA to provide a mutually supporting system.

During FY 1961, the Advanced Research Projects Agency plans to fund three major programs for Space Surveillance. These are continuing programs which are in an advanced stage of development and are partially operative in an interim sense. The first of these is the SPASUR Project, for the purpose of continuing the East-West Satellite Detection Fence. The second is Project SPACETRACK. This project has the objective of receiving and analysing the orbital data that is received from the Fence and other sources, such as the NASA Minitrack network, the military missile ranges, etc., and making this digested and collated information available to interested agencies of the Department of Defense, NASA, and non-governmental agencies where appropriate. The third project is for installation of tracking and data collection devices overseas. In addition, studies of future possible approaches to space surveillance systems, and research and development in the fields of advanced detection, tracking, and data collection devices are planned.

	FY 1960	FY 1961
MISCELLANEOUS PROJECTS	$ 29,343,744	-0-

The obligations shown above will be incurred on projects which will be completed in FY 1960, or are the residual obligations of projects transferred to other agencies during 1959 and 1960 and not shown as comparative transfers in the schedules. Included are projects such as Meteorology and Centaur (transferred to NASA) and space technology feasibility studies (transferred to NASA, Air Force, and Navy).

ferred to NASA, Air Force, and Navy).

	FY 1960	FY 1961
PROGRAM-WIDE MANAGEMENT AND SUPPORT	$ 4,000,000	$ 4,000,000

The Advanced Research Projects Agency is responsible for the planning, development, administration, and management of the various advanced research projects as assigned by the Director, Defense Research and Engineering. In the execution of its program, extensive use is made of existing facilities and services of the military departments, other government agencies, universities, and industry. Under this concept of operations, ARPA does not duplicate or add to that which already has been established and available in the way of facilities and personnel to carry out its program. Accordingly, ARPA can execute its over-all technical and administrative program planning and management responsibilities with a relatively small staff. Through a contract with the Institute for Defense Analyses, ARPA is provided highly specialized scientific and technical program proposals and evaluations which are vital to the successful development, appraisal and technical management of specific areas of advanced research, as assigned.

The funds requested provide for the salaries and other necessary expenses such as travel, communications, equipment, supplies, and professional services required in the planning, direction, and management of the program of advanced research.

Space exploration and related programs

[In millions of dollars]

Amounts in Budget Bureau Fact Sheet, released Jan. 16, 1960 (revised to reflect NASA budget amendments of Feb. 8, 1960)	New obligational authority			
	Fiscal year 1958	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Department of Defense	52	440	[1] 454	407
National Aeronautics and Space Administration	117	305	524	[2] 915
Atomic Energy Commission	20	33	52	47
Total	189	778	1,030	1,369
Expenditures				
Department of Defense	28	231	350	366
National Aeronautics and Space Administration	89	145	325	[2] 640
Atomic Energy Commission	22	28	40	47
Total	139	404	715	1,053

[1] Total differs from NOA amount shown in press release due to program revisions susbequent to Jan. 16, 1960; specifically reduction of ARPA exploratory studies by $10,000,000 and elimination of Mrs. V project.

[2] COMMITTEE NOTE.—The Budget Bureau Fact Sheet actually showed NASA new obligational authority for fiscal year 1961 of $802 million and expenditures of $600 million. While the President's Budget Message referred to a "virtual doubling of expenditures for nonmilitary space projects under the National Aeronautics and Space Administration" on the basis of comparing NASA expenditures of $325 million in fiscal year 1960 with expenditures of $600 million in fiscal year 1961, the two figures are not really comparable, since the fiscal year 1961 estimate of $600 million included $60 million of expenditures against the $140 million requested for Saturn in fiscal year 1961, while Saturn expenditures for fiscal year 1960 (estimated at $45 million) are excluded from NASA expenditures but included in the $454 million attributed to the Department of Defense in fiscal year 1960.

NOTE.—Department of Defense total of $52,000,000 for fiscal year 1958 includes $34,000,000 for Vanguard and $18,000,000 for all other programs.

New obligational authority for Department of Defense space programs as of February 26, 1960

[In millions of dollars]

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Air Force programs:			
Research, development, test, and evaluation, Air Force:			
Samos, Midas, Discoverer:			
Transferred from ARPA	256.9	275.2	156.0
Transferred from "Missile procurement," Air Force			100.0
Other military astronautics	7.2	3.6	5.8
Missile procurement, Air Force			60.0
Military construction, Air Force	10.1		17.1
Total, Air Force programs	274.2	278.9	338.9
Navy programs: Research, development, test, and evaluation, Navy: Military astronautics			1.3
ARPA programs:			
Programs retained by ARPA:			
Salaries and expenses, ARPA:			
Communications	16.7	38.8	42.0
Navigation	10.6	16.8	7.0
Tracking	27.0	12.0	18.0
Exploratory studies	11.0	2.0	
Vehicle modification	4.3	.6	
Total, salaries and expenses, ARPA	69.6	70.2	67.0
Construction, ARPA	28.1	23.5	
Subtotal	97.7	93.7	67.0
Programs transferred to NASA:			
Saturn	24.3	70.2	
Meteorology	12.8		
Centaur	21.5		
Other	10.0		
Subtotal	68.6	70.2	
Total, ARPA programs	166.3	163.9	67.0
Total, new obligational authority for Department of Defense space programs	440.5	[1] 442.8	407.2

[1] Total differs from new obligational authority amount shown in press release due to program revisions subsequent to Jan. 16, 1960; specifically reduction of ARPA exploratory studies by $10,000,000 and elimination of Mrs. V project.

NOTE.—Department of Defense total of $52,000,000 for fiscal year 1958 includes $34,000,000 for Vanguard and $18,000,000 for all other programs.

Included in the Air Force fiscal year 1961 "research, development, test, and evaluation budget justification book is the following material:

"X–15 RESEARCH AIRCRAFT

"The X–15 research aircraft was designed to study problems likely to be encountered in high altitude and hypersonic flight, at speeds up to 4,500 miles per hour and altitudes up to 150 miles. The aircraft portion of this program has been funded in previous years. Fiscal year 1961 funds will be used to complete the development, fabrication and test of the XLR–99 engine and to update the design of the current aircraft.

"DYNASOAR

"Dynasoar is a manned, hypersonic, atmospheric, military test system. Step I in the Dynasoar program will serve as an experimental prototype for follow-on operational exploitation of hypersonic boost glide flight or orbital space flight. Funds will provide an airframe subsystem, a secondary power subsystem and permit design and development of control, guidance, and communications systems. This will lead to the first manned vehicle when a Titan A will be used to boost a one-man vehicle to about [deleted] feet per second."

Atlantic missile range

	Fiscal year 1959, actual	Fiscal year 1960, estimated	Fiscal year 1961, estimated
A. Obligations:			
1. Research, development, test and evaluation appropriation:			
(a) Air Force facilities operated by the Air Force	$30,567	$31,355	$31,355
(b) Air Force facilities operated under contract	69,720	83,615	83,615
2. Military personnel appropriation	8,807	8,423	8,338
Total obligations	109,094	123,393	123,308

NUMBER OF POSITIONS

	Fiscal year 1959, actual end strength	Fiscal year 1960, projected authorization	Fiscal year 1961, projected authorization	Man-years		
				Fiscal year 1959, actual	Fiscal year 1960, estimated	Fiscal year 1961, estimated
B. Personnel:						
1. Government civilians paid out of R. & D. funds	$1,908	$1,939	$1,915	$1,851	$1,917	$1,884
2. Contractor civilians paid out of R. & D. funds	8,216	8,819	8,819	7,647	8,420	8,470
3. Military personnel in research, development, test and evaluation work and support thereof	1,882	1,859	1,813	2,007	1,870	1,836
Total personnel	12,006	12,617	12,547	11,505	12,207	12,190

Included in the Navy fiscal year 1961 "Research, development, test and evaluation" budget justification book is the following material:

PACIFIC MISSILE RANGE

"A second program of national significance is the development and operation of the Pacific Missile Range (PMR). This national range is being developed on the California coast with Point Mugu as its nucleus. It consists of the nearby coastal islands and extends far into the Pacific Ocean including a number of islands in the Mid and Far Pacific. This range is being developed to support the Nation's missile, space and satellite programs.

"The expansion of the Point Mugu complex began in fiscal year 1959. Funding in that year and in 1960 provided minimum initial instrumentation requirements at the PMR launching sites and down-range monitoring installations. The 1961 increment of $68.8 million continues the outfitting of these installations and provides for the operation and management of the existing facilities. The 1961 equipment procurements will improve the capabilities of the polar and sea test ranges, provide additional instrumentation for mainland headquarters and launching sites and nearby coastal islands, and cover the first increment of equipment for the antimissile missile range. Support will be continued for basic range and technical facility operating costs for all range users. This support will cover operations at the Naval Missile Center, Point Mugu, at the Naval Missile Facility, Point Arguello, and at the down-range stations."

Senator YOUNG. Dr. York, it is a pleasure for us to have you here today. I have before me a copy of your short prepared statement. You may proceed to read this prepared statement. Before you do so, I will place the biographies of our two witnesses today in the record.

(The information is as follows:)

OFFICIAL BIOGRAPHY, HERBERT FRANK YORK

Dr. Herbert Frank York, born in Rochester, N.Y., received his A. B. in Physics from the University of Rochester in 1942. After graduating as Phi Beta Kappa scholar with honors, he remained at the university as a teaching assistant and in 1943 obtained his M. S. degree. Later that year, he joined the staff of the University of California Radiation Laboratory at Berkeley.

Between 1944 and 1945, Dr. York worked on the electromagnetic isotope separation program at the Y–12 plant, Oak Ridge, Tenn. Returning to Berkeley, he entered the University of California graduate school, while continuing part-time at the laboratory.

In 1949, Dr. York received his Ph. D. in Physics from the University of California. Later, in 1951, he became a member of the faculty of the Physics Department of the University of California. In 1950, Dr. York, a coleader with Dr. Hugh Bradner, undertook the design and execution of a major diagnostics experiment for Operation Greenhouse at Eniwetok Proving Ground.

In July 1952, when UCRL expanded its research program to include weapons development and other classified programs in applied science, Dr. York was selected to initiate and direct the laboratory program at Livermore, Calif. Under his supervision, the laboratory made major contributions to the varied research programs of the Atomic Energy Commission. Dr. York became an associate director of the University of California Radiation Laboratory and director of the Livermore Laboratory in 1954.

Dr. York, on March 15, 1958, became Director of Research, Advanced Research Projects Division of the Institute of Defense Analyses and Chief Scientist of the Advanced Research Projects Agency of the Office of the Secretary of Defense in the Pentagon, Washington, D.C. Dr. York has served on many governmental advisory committees—among these are the Air Force Scientific Advisory Board, the Army Scientific Advisory Board, and the President's Science Advisory Committee.

On December 24, 1958, President Eisenhower appointed Dr. York as Director of Defense Research and Engineering.

Dr. York is married to the former Sybil Dunford of Berkeley, Calif. They have three children: Rachel, Cynthia, and David. They reside in Alexandria, Va.

BIOGRAPHY OF LT. GEN. BERNARD A. SCHRIEVER, USAF

PART I. NARRATIVE

Lt. Gen. Bernard Adolph Schriever was born in Bremen, Germany on September 14, 1910. His parents emigrated to the United States in 1917, and he became a naturalized citizen in 1923. He received his early schooling in San Antonio, Tex., and was graduated from Texas A. & M., College Station, Tex., in 1931 with a bachelor of science degree.

General Schriever's military career began in 1931 when he accepted a Reserve appointment in the Field Artillery after graduation from Texas A. & M.

Entering flight training at Randolph Field, Tex., in July 1932, he earned his wings and commission as a second lieutenant in the Air Corps Reserve in June 1933 at Kelly Field, Tex.

First assigned as a bomber pilot at March Field, Calif., General Schriever later was stationed at Hamilton Field, Calif., and Albrook Field, Panama Canal Zone. In September 1937, he reverted to Inactive Reserve status, and accepted a position as pilot with Northwest Airlines.

While flying for Northwest he married Dora Brett, daughter of Lt. Gen. and Mrs. George H. Brett, USAF Ret., whom he had met in Panama, while assigned to Albrook Field.

Reentering the service as a second lieutenant in the Regular Army in October 1938, General Schriever was assigned to the 7th Bomb Group, Hamilton Field, Calif. One year later, he was assigned to test pilot duties at Wright Field, Ohio. While at Wright Field, he attended the Air Corps Engineering School, specializing in aeronautical engineering subjects, and was graduated in July 1941. He then entered Stanford University to pursue an advanced course in aeronautical engineering and in June 1942 was awarded a master's degree in mechanical engineering (aeronautical).

In July 1942, General Schriever joined the 19th Bomb Group in the Southwest Pacific. While in that theater, he participated in the Bismarck Archipelago, Leyte, Luzon, Papua, North Solomon, South Philippine, and Ryukyu campaigns.

In January 1943, he became Chief of Maintenance and Engineering Division, 5th Air Force Service Command. He held this position until August 1943 when he was appointed Chief of Staff, 5th Air Force Service Command. In September 1944, he assumed command of the Advanced Headquarters, Far East Air Service Command, and supported theater operations from bases in Hollandia, New Guinea, Leyte, Manila, and Okinawa.

General Schriever was assigned to Air Force Headquarters in January 1946 as Chief, Scientific Liaison Section, Deputy Chief of Staff, Materiel. He held this position until August 1949 when he entered the National War College. Following his graduation in June 1950, he returned to Headquarters, USAF, to become Assistant for Evaluation, Office of the Deputy Chief of Staff, Development. His next assignment in January 1951 was Assistant for Development Planning (an outgrowth of the Evaluation Office). In June 1954, he became Assistant to the Commander, Air Research and Development Command, Baltimore, Md. In July 1954, though retained as Assistant to the Commander, ARDC, General Schriever assumed command of the Air Force Ballistic Missile Division, ARDC, Los Angeles, Calif.

In this capacity, he directed the Nation's highest priority project, the development of an intercontinental ballistic missile. He was responsible not only for pushing forward research and development on all technical phases of the Atlas, Titan, Thor, and Minuteman ballistic missiles, but for concurrently providing the launching sites and equipment tracking facilities, and ground support equipment necessary to these missiles. The propulsion, guidance, and structural techniques developed for the Air Force's ballistic missile program have contributed substantially to the Nation's aerospace capability.

In April 1959, General Schriever was named Commander of the Air Research and Development Command (ARDC) with the rank of lieutenant general. He is responsible for managing the widespread military-science-industry brainpower required to provide the Air Force with the military tools to do its job—weapons of superior quality, created and developed by engineering leadership. General Schriever's management responsibility includes monitorship of over 6,400 research and development contracts in which approximately 1,500 major contractors engage in work on Air Force weapon systems, materiel, equipment, and special projects.

PART II. FACT SHEET

A. Personal data

(1) Born September 14, 1910, Bremen, Germany. Father—Adolph Schriever (deceased). Mother—Elizabeth Schriever.

(2) Married January 3, 1938. Wife—Dora Brett Schriever. Children—Brett Arnold born 1938, now attending GWU; Dodie Elizabeth born 1941, now attending Mt. Vernon Seminary; Barbara Alice born 1949.

(3) Hometown address: San Antonio, Tex.

B. Education

(1) Texas A. & M., College Station, Tex. (construction engineer) B.S. degree, 1931.

(2) Stanford University, Palo Alto, Calif. (aeronautical engineering), M.S. in mechanical engineering (aeronautical) 1942.

(3) Primary and Basic Flight School, Randolph Field, Tex., 1933.

(4) Advanced Pilot Training, Kelly Field, Tex., 1933.

(5) Aeronautical engineer (1 year), 1941.

(6) National War College (regular course) June 1950.

C. Service dates

November 1931–June 1932—Field Artillery, Organized Reserve Corps.

June 1932–June 1933—Flying cadet (training).

July 1933–June 1934—Pilot and engineering maintenance officer.

July 1934–June 1935—Served two active duty tours with the Reserve Forces.

June 1935–June 1936—Extended active duty with Air Reserve.

June 1936–September 1938—Three active duty tours with the Air Reserve.

October 1938–October 1939—In Regular Army and assigned to 7th Bomb Group, Hamilton Field.

October 1939–July 1941—Test pilot and also attended the Air Corps Engineering School.

July 1941–June 1942—Stanford University.

June 1942–January 1943—Joined the 19th Bomb Group in the southwest Pacific. While in that theater participated in eight campaigns.

January 1943–August 1943—Chief, Maintenance and Engineering Division, 5th Air Force Service Command.

August 1943–September 1944—Chief of Staff, 5th Air Force Service Command.

September 1944–January 1946—Commander, Advanced Headquarters, Far East Air Service Command.

January 1946–August 1949—Chief, Scientific Liaison Section, Deputy Chief of Staff, Materiel.

August 1949–July 1950—Student at National War College.

July 1950–June 1953—Assistant for Evaluation, DCS/D, Headquarters, USAF.

June 1953–July 1954—Assistant for Development Planning, DCS/D, Headquarters, USAF.

July 1954–May 1955—Assistant to the Commander, Headquarters, ARDC, WDD, Inglewood, Calif.

May 1955–April 1959—Deputy Commander for Ballistic Missiles, ARDC, WDD, Inglewood, Calif. (WDD changed to BMD June 1, 1957).

April 1959–present—Commander, Headquarters, ARDC, Andrews AFB, Md.

D. Decorations and medals

Purple Heart.
Asiatic-Pacific Ribbon.
Unit Citation (1 Oak Leaf Cluster).
American Defense Ribbon.
Air Medal.
Legion of Merit.
Distinguished Service Medal (1 Cluster).
Philippine Liberation Medal.
American Theater.
National Defense Service Medal.
Guided Missile Insignia.

E. Promotions

Second Lieutenant, November 28, 1931.
First Lieutenant, June 29, 1933.
Captain, April 15, 1942.
Major, June 25, 1942.
Lieutenant Colonel, August 5, 1943.
Colonel, December 21, 1943.
Brigadier General, June 19, 1953.
Major General, December 13, 1955.
Lieutenant General, April 25, 1959.

TESTIMONY OF DR. HERBERT F. YORK, DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

Dr. YORK. Mr. Chairman and members of the committee, I am pleased to have this opportunity to appear before you and to discuss the Department of Defense space interests and space programs.

RELATIONSHIPS BETWEEN DEFENSE AND NASA SPACE PROGRAMS

It is my understanding that the committee is interested in obtaining a more comprehensive understanding of military needs in space, the level of effort required, and the relation of the Department of Defense space programs to those being pursued by the National Aeronautics and Space Administration.

As noted in the National Aeronautics and Space Act of 1958, the role of the Department of Defense in space is limited to those activities peculiar to or primarily associated with the development of weapon systems, military operations, or the defense of the United States, including the research and development necessary to make effective provision for the defense of the United States.

In consonance with this policy, the primary space interest of the Department of Defense is in the application of the new capabilities for flight in space as a means toward achieving a more effective military posture for the United States and its allies, rather than in space flight and exploration as ends in themselves.

DEFENSE SPACE EFFORTS ARE PART OF OVERALL MILITARY PROGRAM

Our space efforts are an integral part of our overall military program and will complement other military capabilities. As space technology expands, new military requirements are likely to materialize. Our objectives, therefore, are (1) the development, production, and operation of space systems which will enhance the overall defense programs; and (2) the development of components for systems, the need for which cannot be clearly demonstrated at this time, but which probably will become necessary in the future.

Thus, considering the nature of our space objectives, it is not logical to formulate a long-range military space program which is separate and distinct from the overall defense program.

DEFENSE-INITIATED SPACE PROJECTS HAVE BEEN TRANSFERRED TO NASA

Also, in keeping with the policy established by the National Aeronautics and Space Act of 1958, certain projects which were initiated by the Department of Defense have been transferred to the National Aeronautics and Space Administration during the past year.

These include Projects Tiros, Centaur and Saturn. In view of the continued interest of the Department of Defense in these projects, various joint DOD–NASA advisory or coordinating groups have been formed to maintain more or less continuous liaison as regards our mutual interest. In addition to these specific groups, there are numerous day-to-day DOD–NASA working groups, which provide essential liaison and cross-fertilization of requirements and technical knowledge on projects of mutual interest.

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GREATER EMPHASIS WILL BE PLACED ON INTEGRATED RANGE REQUIREMENTS

The national ranges and tracking stations of both NASA and DOD have been used heavily in support of space launchings for both agencies. In order to make effective use of these facilities, comprehensive study and analysis of the integrated range requirements for both missiles and space vehicles will be given increasingly greater emphasis as both the missile and space efforts continue to grow.

While many research and development results are useful in both the National Aeronautics and Space Administration and the Department of Defense space effort, the fundamental differences in object and direction will continue to develop widely differing end results.

Space machines and specific hardware are required, such as rocket boosters, and so forth, to fulfill these basic NASA requirements. However, these activities should not be confused with the requirements and needs in establishing and conducting Department of Defense space projects.

DEFENSE INTEREST IN SPACE IS TO ENHANCE MILITARY EFFECTIVENESS

The Department of Defense prime role in space is to use this new environment when it affords the opportunity to enhance the military effectiveness of weapon systems used in the four important roles of defense, offense, information, and logistics.

In developing our current military posture on space systems, the Department of Defense initially directed its attention to those immediately achievable space systems that provided an improved extension of currently used techniques for obtaining military information.

These programs are Samos (reconnaissance), Midas (infrared early warning), Transit (navigation), Vela (nuclear test detection), Shepherd (ground-based tracking), and the like. In addition, Notus (communications) will use satellite relays to enhance our communications ability. A more detailed description of the projects and their status was forwarded to the chairman by the Acting Secretary of Defense on March 28, 1960.

As present there are no full-scale system developments in the defense and offense areas. However, there are certain long leadtime components in support of possible longer term objectives.

Two additional areas of research and development, not system oriented and treating with the broad research and development needs, complete in a general sense the key areas of military research and development directed toward space needs. These are:

(1) General research and component development: This covers, for example, space maneuverable and recovery systems; guidance, control, and navigation components; and rocket engine development.

(2) Ground based equipment: This covers, for example, space surveillance, tracking and control, environmental test facilities, and test centers.

FUNDING OF DEFENSE SPACE PROGRAMS IS SUMMARIZED

The new obligational authority devoted to the Department of Defense space programs and to certain major projects related to space are summarized in the attached table which, if the committee desires, may be included in the record. The totals shown are $686.3 million

for fiscal year 1959 and prior years, $516.4 million for fiscal year 1960, and $471.1 million for fiscal year 1961.

The amounts for fiscal years 1960 and 1961 do not reflect certain program changes presently under consideration. It may also be noted that there has been a change in the base of programs to be supported as a result of transfer of certain program responsibility to the National Aeronautics and Space Administration. For example, Saturn was supported by the Department of Defense in fiscal year 1960 and will be supported by the National Aeronautcis and Space Administration in fiscal year 1961. To this extent the totals do not by themselves demonstrate a trend.

Senator YOUNG. Now, Dr. York, as I understand it, you have completed your prepared statement? If so, the table attached to your statement will be inserted in the record.

Dr. YORK. Yes, sir.

(The information is as follows:)

Military space subsystems funding

[Millions of dollars]

	Fiscal year 1959 and prior	Fiscal year 1960	Fiscal year 1961
Space programs:			
SAMOS, Midas, Discoverer	$356.7	$298.9	$333.0
Notus (communication satellite)	16.7	38.8	42.0
Transit (navigation satellite)	10.6	16.8	7.0
Shepherd (tracking)	31.9	12.0	18.0
ARPA programs transferred to NASA (Saturn, Centaur, etc.)	98.8	77.0	
Other military astronautics (ARPA, Air Force, Navy)	31.8	10.2	7.1
Subtotal, space programs	546.5	453.7	407.1
Major space related projects:			
Dynasoar	32.5	35.0	58.0
X-15	107.3	27.7	6.0
Subtotal, related projects	139.8	62.7	64.0
Total	686.3	516.4	471.1

Senator YOUNG. I am informed that Senator Smith must leave shortly for an important conference—may I ask, Senator Smith, have you some questions?

Senator SMITH. Yes, Mr. Chairman. Thank you.

I listened to Dr. York last week in the hearing of the Appropriations Committee on Defense.

NASA 10-YEAR PLAN WAS DISCUSSED WITH DEPARTMENT OF DEFENSE

Dr. York, Dr. Glennan has presented to this committee a 10-year plan for the NASA space program. Was the Department of Defense consulted in any way in the development of this plan?

Dr. YORK. Yes. Dr. Glennan showed it to me on a number of occasions during its formulation, and showed it also to the Assistant Secretaries of the military departments for Research and Development. And then the Secretary and others in the Department had an opportunity to see it at other times prior to its presentation to the Congress.

Senator SMITH. Was it a matter of simply showing it to him, or asking him for suggestions and recommendations?

Dr. YORK. It was for discussion purposes. I don't remember, however, that anything profound came out of these discussions. But it was for discussion purposes.

DEPARTMENT OF DEFENSE HAS NO LONG-RANGE SPACE PLAN

Senator SMITH. Does the Department of Defense have a comparable long-range 10-year plan for the military space program?

Dr. YORK. No, we have not. We do have some ideas about how various of these programs might develop in the future, but we don't believe that considering our mission we can develop a plan for our space-related programs independently of the overall defense program. For example, the Midas program, in our view, is related to—is something which makes use of space flight. But the needs for it, and the controlling factors when it comes to whether it should grow, stay the same, or stop, are related to our national need for early warning of missile firings. And so on for all of the others. So that we do not have and don't believe we can properly formulate a truly long-range plan.

FUTURE OF MILITARY SPACE PROGRAMS IS DISCUSSED

Senator SMITH. Well, Dr. York, even though you have no formal plan, you must have some idea of just where you are going and what you expect to accomplish in the next 5 to 10 years, specially when you think of the long lead times that are involved. Would you tell the committee what you visualize with regard to the future of space programs in the Department of Defense?

Dr. YORK. We have this group of programs which I mentioned in my statement, where we already—where it is clear to all of us that it is possible to improve—possible to improve the present methods for carrying out these same objectives. That is, in the case of Midas, it looks like a better way to get early warning than in the case of radar.

Now, in the case of each of these, the reconnaissance program is the largest of these, the Samos program. This is in research and development now. It will move in the future from there into operations. Since it obviously involves a fairly sensitive subject, I would not want to go into detail on it, but I will say that the cost of this program will remain about the same—I mean, as it phases from R. & D. into operations.

In the case of Midas, which is for early warning, if this does turn out to be a successful and valuable way of performing the early warning function, this program will expand into the realm of several hundred million dollars a year. It is now running at about $100 million in 1961. But whether or not it actually does move into that range depends on how it stacks up as an early warning program, rather than how it stacks up as a space program.

In the case of the Transit application, it is a relatively small program now. The space end of it, the rocket end, and the question of

the development of the satellite, will probably continue to be a relatively modest program. But if it turns out to be in practice a good operational means for determining location, then there will be probably large sums spent in ground equipment for ships, probably even for aircraft and so on, to make use of the satellite. But money would then be going into navigational equipment aboard ship, rather than into the space side of the picture.

In the case of Vela, which is the nuclear test detection system, most of that incidentally does not involve space. It has just one component that does. If it becomes important to set in motion a program of detection of nuclear weapons in space, using satellites, this one will be very expensive indeed. Also, just a rough guess, some hundreds of millions per year.

Shepherd, which is ground based detection of other satellites is one which is even harder to predict, because it depends on precisely what the Air Defense people believe they will require in the way of detail with respect—and Intelligence people, too—with respect to details on what it is that is in orbit.

And the communications satellite is another one which will develop into the range of a hundred million, or perhaps several hundred million dollars a year, depending on how useful and important this is judged to be as one of many ways of performing interocntinental communications.

Beyond these, until we know more than we do about the possible offensive and defensive applications of space, it is not possible to make a peridction at all. Except for one special case which falls outside of these. In the general research and component areas, the Dynosoar program is the big one of those, and it will also expand, if as we develop the 1962 and get into the 1963 budgets, it appears this is still a fruitful way to go, this program will also expand.

Senator SMITH. You should have the first item becoming operational. Would you care to indicate in open session something as to the timing of it?

Dr. YORK. No, I don't believe I should, Senator Smith.

AIR FORCE IS DEVELOPING SOLID ROCKET WITH 20 MILLION POUND-SECONDS OF THRUST

Senator SMITH. Dr. York, there have been press reports that the Air Force is developing a solid propellant rocket booster which would have a growth potential to two million pounds of thrust. What can you tell us about this project?

Dr. YORK. Well, this is part of the Air Force's rocket engine development program. It is not correct to describe it as a booster. It is a solid rocket engine, a solid rocket motor. The first phase, the Air Force is planning on asking for the development of a grain—a grain is what the total piece of propellant is called—and nozzle combination, that would have something of the order of 10 or 20 million pound-seconds of thrust. That is the product of the thrust and the number of seconds during which the thrust is maintained.

Whether this is 2 million pounds for 5 or 10 seconds, or whether it is 1 million pounds for 10 or 20 seconds, I am not quite sure that that figure has been decided on.

At any rate, this first phase—and what happens beyond that depends entirely on what happens in the first phase—this solid rocket, while the thrust is very big, 2 million pounds, the total pound seconds of thrust sometimes is smaller than many rockets which we have today. The Titan, for example, is 50 million pound seconds, or something of that sort. The Atlas is about 50 million pound-seconds. So it is a big rocket in terms of thrust, but it is not a big rocket in terms of the job that it can do. It is just—it just is a step, another step in the direction of exploring rocket engines.

In this case, the application of large solid grains to rocket engines.

AIR FORCE SOLID ROCKET PROGRAM DOES NOT INFRINGE ON NASA RESPONSIBILITIES

Senator SMITH. Since NASA has been given the responsibility for the development of superboosters, isn't that project an infringement by the Air Force?

Dr. YORK. I don't think so, because I wouldn't call this a super booster. For instance, the Saturn boosters and the Nova boosters are vastly larger than this in terms of pound seconds, and it is pound seconds that count when you are asking what you can get into orbit with a particular booster, rather than just pounds.

This program has been discussed with the NASA people. They are aware of this, and other things we are doing in this region. This is not a booster. This is a big solid rocket engine.

Senator SMITH. Then Dr. York you feel there is no conflict, there is no overlapping or duplication between the Air Force or the Defense Department and NASA?

Dr. YORK. Well, I can't swear there is none. However, I believe that there is a minimum. An item such as this is checked out before it is done to look into that very question—is NASA planning on doing something like this, or they would presumably check with us or with the Air Force before they instituted such a program.

Senator SMITH. Thank you very much, Mr. Chairman. I am sorry to have to leave. But since I did hear Dr. York in executive session the other day——

Senator YOUNG. Yes. We are all exceedingly busy. It happens I am serving as temporary chairman here because the chairman of this subcommittee, Senator Stennis, was also compelled to be absent temporarily.

Senator Symington, have you some questions?

HEARINGS ARE BEING HELD BY NASA AUTHORIZATION SUBCOMMITTEE

Senator SYMINGTON. Thank you, Mr. Chairman. I notice Dr. York's statement indicates it is presented before the Committee on Aeronautical and Space Sciences. I am not a member of this subcommittee, which I wish I was, but I am not.

Senator YOUNG. This is a subcommittee.

Senator SYMINGTON. What is the name of the subcommittee?

Senator YOUNG. This is the NASA Authorization Subcommittee.

Senator SYMINGTON. Thank you, Mr. Chairman.

DR. YORK WOULD NOT RECOMMEND CONSOLIDATED RESPONSIBILITY FOR SPACE PROGRAMS

Dr. York, I notice in your statement you say, on page 2—

Considering the nature of our space objectives, it is not logical to formulate a long-range military space program which is separate and distinct from the overall defense program.

How do you correlate that statement with the arbitrary separation of the military and the civilian space activities?

Dr. YORK. I don't think these are—I don't really understand the problem you have in mind. The civilian program, since it does have space flight and exploration as an end in itself, can treat space as an entity and as an objective, and therefore formulate a long-range program. Our objective is defense, and we use space flight as necessary to augment defense. We are interested in these satellite programs only on the basis of whether or not they are a better way to do something that can be done from the ground or otherwise.

Senator SYMINGTON. You are satisfied, then, to let the military space program proceed under one head, and the civilian space program proceed under another, is that right?

Dr. YORK. That is a practical way to proceed.

Senator SYMINGTON. I didn't ask you whether it was a practical way to proceed or not. I asked you whether you were satisfied with it.

Dr. YORK. I am satisfied that it is a workable way.

Senator SYMINGTON. And you would make no recommendations to further consolidate responsibility and authority in the space field, is that correct?

Dr. YORK. No, I would not.

Senator SYMINGTON. Now, you say—

Space machines and specific hardware are required, such as rocket boosters and so forth, to fill these basic NASA requirements. However, these activities should not be confused with the requirements and needs in establishing and conducting Department of Defense space projects.

I am interested in your using the word "confused." Don't you think that we would have less confusion if we had, regardless of whether he was a military person or civilian person, if we had one person in charge of our space activities for both military and civilian?

Dr. YORK. No, I don't, and the reason is because the objectives are so very different.

DETAILED DESCRIPTION OF MILITARY SPACE PROGRAMS WAS FORWARDED TO COMMITTEE CHAIRMAN

Senator SYMINGTON. Now, you say here, "developing our current military posture on space," and so forth, you mention some programs—Transit, Vela, Samos, Shepherd, and you say—

A more detailed description of the projects and their status was forwarded to the chairman by the Acting Secretary of Defense on the 28th of March.

What chairman are you talking about—the chairman of the full committee or the chairman of the subcommittee?

Dr. YORK. The request came from Senator Johnson. The response from the Acting Secretary was to Senator Johnson.

FUNDS FOR MILITARY SPACE PROGRAMS DECREASED IN FISCAL YEAR 1961

Senator SYMINGTON. Now, on the last page of your statement, you show that we are spending less money in the fiscal year 1961, as far as your interests are concerned, than we did in the fiscal year 1960, by $40 million. And then you say—

The totals do not by themselves demonstrate a trend.

What do you mean by that?

Dr. YORK. I mean by that as it goes on here that in fiscal 1960 there were certain programs in the Department of Defense which have subsequently been transferred to NASA. If you look at those programs which are in the Department of Defense in 1961, and those which were, and then follow them back into 1960, you find that they are of course increasing. This decrease is more than made up for by the fact that Saturn was in the Department in one year and not in the next.

SATURN FUND REQUESTS WERE CUT $163 MILLION IN 2 YEARS

Senator SYMINGTON. How much did you cut the Saturn program as against the request for Saturn by the Army in fiscal year 1960?

Dr. YORK. You would have to—that is a complicated question, because you would have to ask which request, because it changed very frequently.

Senator SYMINGTON. General Medaris told me last year Saturn was cut from $140 million to $78 million, as I remember the figures, for the fiscal year 1960—this fiscal year.

Dr. YORK. The largest figure which was requested for Saturn was $140 million. That was the last figure. Their figures were considerably smaller at the time the budget was being made up. The final figure that was actually devoted to the project was about $77 million.

Senator SYMINGTON. Was General Medaris right in telling me in Huntsville in September 1959 that the Saturn program had been cut from $140 million to $78 million or $77 million? Was that correct?

Dr. YORK. I don't know if it is correct to say it has been cut. His request has not been complied with. That is correct. But at no point was there one amount of money in and then later that amount of money refused. In fact, the money was increased during the course of the year.

Senator SYMINGTON. In other words, the request of the Army was not granted, is that correct?

Dr. YORK. I am not sure this is the request of the Army. I would have to consult the record on that. This is the request of the commander of the Army Ballistic Missile Agency. I am not sure that is the request of the Army.

Senator SYMINGTON. Was it a request of General Medaris?

Dr. YORK. Yes, that is correct. General Medaris did at one time request $140 million, which was not——

Senator SYMINGTON. And got $77 million, is that right?

Dr. YORK. And ultimately ended up with $77 million.

Senator SYMINGTON. So that is a difference of $63 million.

Now, General Medaris also told me last September that he had requested for this year $250 million, and was being allowed $150 million.

Dr. YORK. That is about right.

Senator SYMINGTON. So his request was cut $100 million, is that right?

Dr. YORK. That is about right.

Senator SYMINGTON. A total in 2 years of $163 million, correct?

Dr. YORK. Yes; in terms of his request.

Senator SYMINGTON. That is what we are talking about now.

Dr. YORK. Yes.

RECENT SATURN $90 MILLION INCREASE DOES NOT FULLY RESTORE PREVIOUS REDUCTIONS

Senator SYMINGTON. There has been quite a lot of publicity about an increase in the amount of money that the Saturn program has received after the program was transferred from the Army to NASA. How much was that?

Dr. YORK. About $100 million, a little less.

Senator SYMINGTON. I saw a figure of $90 million.

Dr. YORK. Yes; I think $90 million is right.

Senator SYMINGTON. You don't think $100 million is right?

Dr. YORK. About $100 million, a little less. That is $90 million.

Senator SYMINGTON. Based on the figures given me by General Medaris, who naturally has been interested in this program, even though we seem to be stressing the future importance of Saturn, the net in the last 2 years, instead of being an increase of $90 million, has been a reduction from the standpoint of what General Medaris and Dr. von Braun wanted of $73 million; is that correct?

Dr. YORK. That is the way the figures are adding up, that there is $73 million less in these 2 years than General Medaris requested.

Senator SYMINGTON. I checked all these figures right after having been in Huntsville in September——

Dr. YORK. I am not arguing about the figures, Senator, but——

Senator SYMINGTON. With Dr. von Braun, and he confirmed the figures that were given to me by General Medaris.

Dr. YORK. I have no quarrel with the arithmetic.

BUDGET GUIDELINES PREVENTED ARMY FROM REQUESTING FULL AMOUNT FOR SATURN

Senator SYMINGTON. I don't want to quarrel with anybody. I just want a little more information about what is going on in the space program for the benefit of the American people.

Now, did the budget guidelines prevent the Army from making a request for the full amount that General Medaris wanted?

Dr. YORK. In a sense they did, but not in detail.

Senator SYMINGTON. Now, you are going to have to clear me up on that. In a sense they did, but not in detail. I don't quite understand that.

Dr. YORK. What I mean is this: As long as the defense budget is in the neighborhood of about 40 or 41 or 42 or 43 billion dollars a year,

considering all of the various things we had to do, then about these figures of $77 million one year and $130 million the other year, $140 million the other year, are what made in our judgment the best sense.

In other words, what I am saying is that if the budget guidelines had been $163 million more, that would not have made the difference with regard to whether General Medaris got all of what he asked for or not. So the budget was controlling, but only in the sense that it was about $41 billion.

Senator SYMINGTON. Mr. Reporter, please read my question, and Dr. York's answer to my question.

(The question and answer were read by the reporter.)

Senator SYMINGTON. Since I don't quite understand all the details of that answer, I would like to ask the question again.

Mr. Reporter, will you repeat my question, and then Dr. York, will you try to answer the question so I can understand it. Will you repeat the question, Mr. Reporter?

(The question was read by the reporter.)

Dr. YORK. Well, the answer is that, "Yes, in a general way."

DELAY IN SATURN PRIORITY AND FUNDING HAS DELAYED SCHEDULE 6 MONTHS

Senator SYMINGTON. Well, I can understand that. Thank you.

In a hearing the other day, our able staff member, Mr. Lehrer, asked this question of Dr. von Braun:

> Could you tell us if your recommendations last year for priority and funding for Saturn had been approved, would we be firing a Saturn before the time set under the current accelerated schedule?
>
> Dr. VON BRAUN. Yes; I think the answer to your question is "Yes." I mean, had we received more money in 1960, half a year earlier, we would be half a year ahead on the program.
>
> Mr. LEHRER. A half a year ahead of the current program?
>
> Dr. VON BRAUN. Yes.

Would you agree with that?

Dr. YORK. It is about right. It depends——

SATURN HAD TO COMPETE WITH OTHER DEFENSE PROGRAMS WITHIN $41 BILLION DEPARTMENT OF DEFENSE BUDGET

Senator SYMINGTON. What I am getting at is what is the matter with the sales capacity of the Army? I have a great deal of respect for what General Medaris and Dr. von Braun built up in Huntsville. I went down and looked at it. I spent days down there. I talked with their shopmen, their superintendent. It seemed to me they were doing a mighty fine job. I never saw a better job anywhere, as far as people working for the Defense Department was concerned.

Now, why is it that they were held down so by a monetary restriction to the point where they now testify that one of the chief reasons we are behind the Russians today as far as we are behind is because of the lack of money, and then all of a sudden, when the transfer is made to the civilian agency, the money that was holding us back from this most important development suddenly was at least partially forthcoming. At least they got back more than half of the money they had asked for and had been denied.

Clear me up about that, will you. Is it a recognition at this date of the importance of Saturn, or is it simply that the Army doesn't have the sales capacity or the dining-out power of NASA?

Dr. YORK. Well, I don't know about the dining-out power. Basically, it is the fact that now this program comes under the authority of an agency that has space flight and exploration as its principal end. Previously it was in the Department of Defense, in which it had to compete for available resources against all of the other things which were going on, which were pointed toward, in many cases, objectives which, while not identical, were nevertheless extremely important and designed to prevent other cases where we might end up behind.

This extra money was being asked for essentially, for example, the cost of a Polaris submarine. And when it is in the Department of Defense, that is the kind of thing it is competing with. When it is in NASA, it is being handled by an agency for which it is a primary means for actually achieving the fundamental end of that agency. That wasn't so in the Department of Defense.

Senator SYMINGTON. I want to compliment you on a very fine and forthright answer. As I get it from your testimony, there are guidelines which based on competition limit the amount of money that is available to a vitally important project in the Defense Department, and those guidelines are not controlling when it is shifted to a civilian agency. Is that correct?

Dr. YORK. There were no guidelines issued from on high about how much could be put on Saturn. But it was obvious——

Senator SYMINGTON. What do you mean about competition with Polaris, then?

Dr. YORK. But it was obvious in the Department of Defense that we were going to have about $41 million, and when you have about $41 million and see all the things you have got to do, then this $130 million is about a right amount to put there—considering its relative importance compared to other things competing for those same funds.

PREPAREDNESS SUBCOMMITTEE RECOMMENDATIONS ON MILLION-POUND THRUST ROCKET ENGINE ARE CITED

Senator SYMINGTON. The Preparedness Subcommittee, of which I have the honor to be a member, unanimously requested immediate acceleration of the million pound rocket engine over 2 years ago. But your testimony is until it was transferred from the Army to NASA, there was no acceleration, is that correct?

Dr. YORK. No, sir, that is not my testimony, because at the time the committee you speak of made that recommendation, there was no Saturn program at all. So it was accelerated from nothing to $77 million, to then $130 million, and the Nova program was also instituted.

Senator SYMINGTON. In January 1958 there was no high booster program at all at Huntsville?

Dr. YORK. No, sir, there was no Saturn program, which was the million and a half pound booster program.

Senator SYMINGTON. What was the thrust program called at Huntsville at that time?

Dr. YORK. There was no program that I am aware of in January 1958 beyond the Jupiter program.

Senator SYMINGTON. And what was the thrust of the Jupiter?

Dr. YORK. That was 135,000 to 150,000 pounds. Of course, we had bigger thrust boosters in development elsewhere.

NUCLEAR TEST BAN IS DISCUSSED

Senator SYMINGTON. One of the chief reasons I wanted to come to this hearing was an article in the Washington Post of today. It said—

Senators are expected to question Pentagon chiefs today about a sharp split among defense officials and atomic scientists over a proposed new international agreement banning all nuclear weapons tests.

Most of the Nation's military men and many Atomic Energy Commission officials—including a majority of the scientists at the Livermore Laboratory in California—reportedly feel that a continued, indefinite moratorium on even underground A-tests will weaken the United States militarily.

Do you agree with that? Are you one of those people that agrees with that?

Dr. YORK. I have not really been closely connected with this problem in recent days, Senator.

Senator SYMINGTON. So you wouldn't know how you felt about it?

Dr. YORK. I don't have a—I am afraid I don't have a handy short form opinion.

Senator SYMINGTON. The article continues—

Some top civilians at the Pentagon as well as AEC experts—including many scientists in the Los Alamos Laboratory in New Mexico—are said to take a different view.

Herbert F. York, Pentagon director of research and engineering, and Lt. Gen. Bernard Schriever, chief of the Air Force research and development command, appear before the Senate Space Committee this morning to give testimony on the civilian space program. Members of the group indicated last night that they will be questioned about the split over A-testing.

Mr. Chairman, that is the reason I am appreciative of your gracious request to let me question the witness this morning.

Both sides agree that further testing is not essential to make the great majority, if not all, of the presently planned American atomic weapons work.

Do you agree with that?

Dr. YORK. Where is that?

Senator SYMINGTON (continuing):

Both sides agree that further testing is not essential to make the great majority, if not all, of the presently planned American atomic weapons work.

Dr. YORK. To the extent you can discuss something this complicated that briefly, that is pretty close to right.

Senator SYMINGTON (continuing). They also agree that further testing would make them much more efficient, with less fallout, and probably cheaper.

Can you comment on that?

Dr. YORK. That is certainly correct.

Senator SYMINGTON (continuing). The argument centers on two points: the importance of advantages to be gained by further testing, and whether Russia will abide by a promise not to make underground tests that cannot be detected.

Would you agree that those are the two points on which the argument centers?

Dr. YORK. They are certainly much more important points than many which I have heard in this connection.

Senator SYMINGTON (continuing). This is the picture on major improvements: Reduction is sought in the weight and size of ballistic missile warheads, with comparable increase in the yield, so that the United States can build the "invulnerable deterrent" that has been the national aim.

This is now generally taken to require a mobile long-range missile that an enemy could not count on destroying by a surprise attack. The Navy's Polaris, and the Air Force's railroad-mounted Minuteman certainly will work without further testing—although some risk is being taken by miniaturization of warhead parts—but further testing could give them much greater punch and thus make them much better weapons.

Do you agree with that?

Dr. YORK. That is correct.

Senator SYMINGTON. I have no position in this, but as long as I read the article with interest, I wanted to get your opinion.

May I say I have very great respect for your opinion, as you know.

Developing of a family of small, tactical A-weapons for battlefield use is hardly practicable without testing.

Would you agree with that?

FURTHER WORK ON SMALL ATOMIC WEAPONS WOULD BE FRUITFUL

Dr. YORK. Well, there are already small—some small A-weapons for battlefield use. This is one of the areas in which I am sure there is considerable room—a very large amount of room for progress. There already are some. But this is one of the places where further work would be most fruitful.

Senator SYMINGTON. We can proceed to the next point, which is really a corollary of the first one that I presented to you.

Scientists believe that cheap "fission-free" bombs for battlefield use can be developed, and it is clear that both the United States and Russia are working on the problem.

By "fission free", I presume they mean a fusion bomb that would not have to be ignited by an atomic bomb, is that correct?

Dr. YORK. I am sure that is what people are talking about, yes.

Senator SYMINGTON. Thank you, Doctor.

It continues—

Given a stalemate of mass destruction ICBM's, the side that introduced such a new weapon in a limited war could well win it.

Would you agree with that?

Dr. YORK. Well, it would be a factor. But I doubt it would be the primary or dominating factor with regard to who would win or lose a limited war.

Senator SYMINGTON. Mr. Chairman, I have just a little more. I would like to read this article in the record.

The real issue between the military men and scientists who differ over the test ban is not merely improving their major weapons. It is whether a continued moratorium will make a nuclear catastrophy more or less likely for the United States.

Would you agree with that?

Dr. YORK. Very much so. I think that is the real issue in a nutshell. And the only thing that really matters.

Senator SYMINGTON. Which do you think is right?

Dr. YORK. That is a most difficult question, Senator. It involves a great deal more than just research and engineering on defense matters.

Senator SYMINGTON. I understand that. But this is an able article, and the people are intensely interested. And you are the head of a very important component part in the Government incident to this problem.

Would you care to give your personal comment and opinion on it?

Dr. YORK. I have not been asked to study this problem. I think it is an extremely important and extremely difficult one. I don't feel that I have a worthwhile opinion to give in public on this matter.

Senator SYMINGTON. Thank you.

It says—

If Russia quits testing also, while the United States still is ahead in A-weapons development, would not this Nation be better off?

I would like the record to show, that Dr. York and I have not discussed this in any way before the hearing.

Dr. YORK. That is quite true.

Senator SYMINGTON (continuing).

If Russia quits testing also, while the United States still is ahead in A-weapons development, would not this Nation be better off?

I am sure your answer would be yes to that, would it not?

Dr. YORK. I think the answer is yes.

Senator SYMINGTON. Then it says—

Assuming the U.S.S.R. is far behind the United States in a submarine launched missile, would it not be better to forego an improved Polaris rather than let Russia gain a slightly inferior weapon of this kind to fire from its big submarine fleet at vulnerable American coastal cities?

Would you care to comment on that?

Dr. YORK. Well, I think the idea being expressed there is correct, that there is a bigger difference between a Polaris and no Polaris than there is between a better Polaris and a pretty good Polaris, if I understand the statement correctly.

NUCLEAR TEST BAN AGREEMENT INVOLVES POLITICAL CONSIDERATIONS

Senator SYMINGTON. And next to the last paragraph—

Will not a test ban agreement reduce world tensions and help break down the Iron Curtain?

What would be your comment on that?

Dr. YORK. I don't know. That is a statement which is a strictly political question.

Senator SYMINGTON. Well, certainly a test ban agreement arrived at on the right terms would help break down the Iron Curtain, wouldn't it?

Dr. YORK. The terms that people are talking about involve inspection, and that represents a small dent in the Iron Curtain. But—the answer is yes, but I don't feel particularly qualified to give an answer.

Senator SYMINGTON. If we got what we thought was right, from the standpoint of the right kind of an agreement that would certainly help reduce world tension, wouldn't it?

Dr. YORK. I believe so, speaking as a private citizen who reads the newspaper. I believe so.

Senator SYMINGTON. Wouldn't such an agreement help prevent other countries from joining the Atomic Club, most importantly Red China?

Dr. YORK. I should hope it would.

Senator SYMINGTON. These are in the form of questions from the article. I am just putting the article in the record, which interested me a great deal.

Final paragraph—

The major answer of the advocates of further testing is that Russia has gained in nuclear weapons development since the multilateral test bans were adopted 18 months ago.

Do you agree with that?

Dr. YORK. Would you say that again?

Senator SYMINGTON (continuing):

The major answer of the advocates of further testing is that Russia has gained in nuclear weapons development since the multilateral test bans were adopted 18 months ago.

Dr. YORK. Well, I have no knowledge that confirms that, Senator.

Senator SYMINGTON. The final sentence:

No one can say whether the Soviets will continue to gain through sheer momentum, assuming they don't cheat on their pledge not to test.

What would be your position on that?

Dr. YORK. I didn't understand it. What was it? I didn't understand it.

Senator SYMINGTON (continuing):

No one can say whether the Soviets will continue to gain through sheer momentum, assuming they don't cheat on their pledge not to test.

Dr. YORK. I don't know what a gain through sheer momentum means. If they are not testing, I don't know what it means.

Senator SYMINGTON. Mr. Chairman, I want to thank you and the committee for your courtesy in letting me read this complete article in the record. And because of the nature of Dr. York's position, and his very great knowledge in this field, I thought it would be interesting to see what his opinion was on the matters that have been presented. I thank the Chair.

Senator YOUNG. May I, as acting chairman, say to my distinguished colleague that I hold in my hand a clipping of the article referred to, "Senators May Explore Split on A-Ban Merits," and I will pass this to my colleagues, and later on I will ask unanimous consent that this be inserted and made a part of the record.

Senator SYMINGTON. Mr. Chairman, I ask that the article I have read from entitled "Senators May Explore Split on A-Ban Merits," by John G. Norris, be inserted at this point in the record?

Senator YOUNG. That is the article I have before me. I had intended to ask some of the questions that my distinguished colleague has asked. Without objection, it will be inserted in this part of the record.

(The article referred to is as follows:)

[Washingotn Post and Times Herald, Mar. 30, 1960]

SENATORS MAY EXPLORE SPLIT ON A-BAN MERITS

(By John G. Norris, staff reporter)

Senators are expected to question Pentagon Chiefs today about a sharp split among defense officials and atomic scientists over a proposed new international agreement banning all nuclear weapons tests.

Most of the Nation's military men and many Atomic Energy Commission officials—including a majority of the scientists at the Livermore Laboratory in California—reportedly feel that a continued, indefinite moratorium on even underground A-tests will weaken the United States militarily.

Some top civilians at the Pentagon as well as AEC experts—including many scientists at the Los Alamos Laboratory in New Mexico—are said to take a different view.

Herbert F. York, Pentagon Director of Research and Engineering, and Lt. Gen. Bernard Schriever, Chief of the Air Force Research and Development Command, appear before the Senate Space Committee this morning to give testimony on the civilian space program. Members of the group indicated last night that they will be questioned about the split over A-testing.

Both sides agree that further testing is not essential to make the great majority, if not all, of the presently planned American atomic weapons work. They also agree that further testing would make them much more efficient, with less fallout, and probably cheaper.

The argument centers on two points: the importance of advantages to be gained by further testing; and whether Russia will abide by a promise not to make underground tests that cannot be detected.

This is the picture on major improvements:

Reduction is sought in the weight and size of ballistic missile warheads, with comparable increase in the yield, so that the United States can build the "invulnerable deterrent" that has been the national aim.

This now generally is taken to require a mobile long-range missile that an enemy could not count on destroying by a surprise attack. The Navy's Polaris and the Air Force's railroad-mounted Minuteman certainly will work without further testing—although some risk is being taken by miniaturization of warhead parts—but further testing could give them much greater punch and thus make them much better weapons.

Development of a family of small, tactical A-weapons for battlefield use is hardly practicable without testing.

Scientists believe that cheap "fission-free" bombs for battlefield use can be developed, and it is clear that both the United States and Russia are working on the problem. Given a stalemate of mass destruction ICBM's, the side that introduced such a new weapon in a limited war could well win it.

The real issue between the military men and scientists who differ over the test ban is not merely improving their major weapons. It is whether a continued moratorium will make a nuclear catastrophe more or less likely for the United States.

If Russia quits testing also while the United States still is ahead in A-weapons development, would not this Nation be better off? Assuming the U.S.S.R. is far behind the United States in a submarine-launched missile, would it not be better to forego an improved Polaris rather than let Russia gain a slightly inferior weapon of this kind to fire from its big submarine fleet at vulnerable American coastal cities?

Will not a test ban agreement reduce world tensions and help break down the Iron Curtain? Won't such an agreement help prevent other countries from joining the "atomic club," most importantly, Red China?

The major answer of the advocates of further testing is that Russia has gained in nuclear weapons development since the multilateral test bans were adopted 18 months ago. No one can say whether the Soviets will continue to gain through sheer momentum, assuming they don't cheat on their pledge not to test.

Senator YOUNG. Now, as acting chairman, I just have a very few questions, Dr. York.

Will you refer to the second page of your prepared statement.

Dr. York, you and I are civilians. It seems to me that your office is located in the Pentagon, is it not?

Dr. YORK. Yes, sir.

REFERENCE TO CROSS-FERTILIZATION IS GOBBLEDYGOOK

Senator YOUNG. It seems to me that you have been guilty of using some Pentagonese gobbledygook on page 2 of your statement.

I am going to ask you to clarify this.

Now, I am going to refer to the long sentence where you use the expression of cross-fertilization. I am familiar, as a layman, with calling manure fertilizer, fertilizer manure, and other names, perhaps. But I am puzzled by this sentence of yours, and I am quoting now:

> In addition to these specific groups, there are numerous day to day DOD–NASA working groups, which provide essential liaison and cross-fertilization of requirements and technical knowledge on projects of mutual interest.

Now, it seems to me that you knocked the ball out of the lot on that. It is beyond me. Will you explain that in simple terms, so we can all understand it?

Dr. YORK. I would like to say, first I don't think you can blame this on standard Pentagonese. This is probably more of a personal fault in my own office. At least the use of fertilization in this sense.

Senator YOUNG. Well, it doesn't matter who is to blame. We want it simplified.

Dr. YORK. The point here simply is that there are working between the Department of Defense and the NASA numerous groups on all sorts of subjects. These groups are—many of them, I guess probably most of them, in terms of numbers, are composed of technical people who are fairly knowledgeable with regard to what is going on, and their purpose is to coordinate programs in the sense of trying to uncover unnecessary duplication, and to exchange ideas. And the cross-fertilization of technical knowledge is simply a complicated way of saying that they are exchanging ideas.

Senator YOUNG. Well, it is complicated. I will not spend any more time on that. As a new Senator, a year and 3 months ago, I first learned in the Pentagon you used the word "phaseout." It would be too simple to say "Stop." I received a notice they were phasing out the Shelby Military Depot. They could say they were closing it, but that is too simple. But now I do have some serious questions to ask you.

WE ARE NOT SPECIFICALLY DEVELOPING SPACE SATELLITES WITH NUCLEAR WARHEADS

According to a United Press dispatch from Geneva, on March 28, it was stated, and I quote:

> The Western Powers today proposed an early East-West ban on space satellites with nuclear warheads, calling on the Soviet Union to agree to such a ban as one of the first stages of any disarmament agreement.

Now, Dr. York, first, could you tell us what is meant by space satellites with nuclear warheads.

Dr. YORK. Well, this is something that has been suggested by a number of people. What people usually have in mind when they talk about that is a satellite—I mean a satellite in orbit, and containing on board a nuclear weapon, generally conceived of as being fairly powerful. And this nuclear weapon could be, then, through the use of retro rockets and so on, and various guidance and control gadgetry

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and mechanisms—could be brought down on command, or at a predetermined time, on a predetermined target. So that what we are talking about here is what sometimes has been referred to as a bombardment satellite.

That, I think, is what people are talking about in this connection.

Senator YOUNG. Do we have one under development?

Dr. YORK. No; we don't. It is the sort of thing on which studies are going on. There is no development program to build a bombardment satellite. That is what I meant in my statement when I said there are no programs in this area of defense or offense.

On the other hand, much of the work that would have to be done if such a bombardment satellite were to be built is being done in the natural course of doing other programs. So that many, or I guess it is correct to say most, of the problems which would have to be solved in order to build an offensive bombardment satellite, are being solved in connection with such programs as Discoverer, for example.

BAN ON BOMBARDMENT SATELLITE NOT DANGEROUS TO THE UNITED STATES

Senator YOUNG. Well, Dr. York, recognizing that this morning we are in an open session, how much can you tell us about the implications of this proposal?

Dr. YORK. Of the Geneva——

Senator YOUNG. The proposal that I read to you.

Dr. YORK. The proposal to forbid this?

Senator YOUNG. Yes; the ban on space satellites with nuclear warheads. Calling on the Soviet Union to agree to such a ban as one of the first stages of any disarmament agreement.

Dr. YORK. Well——

Senator YOUNG. In other words, if this proposal were to be accepted by both sides, I want to ask you later, would it hamper our development of military space satellites? But my question now is, recognizing that we are in open session, how much can you tell us about the implications of the proposal?

Dr. YORK. I am hampered somewhat by just lack of having thought very much about it, as well as by the open session, Senator. But it doesn't offhand strike me as being a particularly dangerous proposal from the point of view of defense.

At the present time, I might say we don't see any advantage to this particular means of delivery over the intercontinental ballistic missile, which is also—which is a very effective way of delivering large explosive payloads, large distances, with a high degree of accuracy, and in a very short time.

Senator YOUNG. Well, then, would you say that if this proposal were accepted by both sides, it would not hamper the development of military space satellites?

Dr. YORK. That is right. As you read—as I understand your reading of the proposal in the newspaper clipping, I don't believe it would hamper our development of military satellites.

Senator YOUNG. Do you wish me to read it again?

Dr. YORK. No; it wasn't your reading. It is just a question of how detailed a report this is of what was actually said in Geneva.

Senator YOUNG. Regarding this proposal of the Western powers for an early East-West ban on space satellites with nuclear warheads,

Dr. York, what is your personal view of the desirability of this step, if you care to state it in an open session?

Dr. YORK. Well, again, I am not sure I have any really worthwhile views. It strikes me that this sort of thing is not very close to the point. I don't really object to it. I don't know exactly what good it would do, either.

NOTIFICATION OF ROCKET AND SATELLITE LAUNCHINGS WOULD AVOID FALSE ALARMS

Senator YOUNG. It has also been reported, Doctor, that one of the proposals in the disarmament talks is for a system of prior notification of all rocket and satellite launchings. What are the implications of such a proposal?

Dr. YORK. Well, I don't know all the implications, Mr. Chairman, but certainly the reason for this is to avoid false alarms to our missile defense systems, to enable us to presumably have a chance to perhaps inspect what it is that is going up. I don't know all the implications.

Senator YOUNG. Well, do you have an opinion that surveillance satellites might ever be operated on an international basis, by an organization such as, for example, the United Nations?

Dr. YORK. Well, there is no technical reason why they couldn't be, and I am afraid I don't know whether there are political reasons that make it possible or impossible. There is no technical reason why they couldn't be.

NASA IS PROVIDING NO HELP ON MIDAS PROGRAM

Senator YOUNG. May I ask what kind of help, if any, are you getting from NASA in the development of the Midas satellite program?

Dr. YORK. No direct help in that connection.

Senator YOUNG. Now, regarding the article in today's Washington Post, which was referred to earlier by Senator Symington and by me. You have a copy of it, do you not?

Dr. YORK. Yes, sir.

Senator YOUNG. That article outlined some of the arguments pro and con in respect to banning nuclear tests, and the implication that it has for military programs. Do you disagree, Doctor, in the substance of that article?

Dr. YORK. No; I don't disagree in the substance.

Now, I am saying that without going over it with a fine tooth comb, but in talks about—this mentions a number of points that go to making up the argument—I seem to have the wrong edition—but, by and large——

Senator YOUNG. The story is about the same. One edition has a couple of more paragraphs. Go ahead.

Dr. YORK. Would you repeat the question?

Senator YOUNG. Yes. The substance of my question is related to this long article in today's Washington Post, under the caption, "Senators may explore split on A ban merits." This entire article will, by unanimous consent, become a part of the record of today's hearing. Reading that article, considering it, considering the ques-

tions of Senator Symington, I believe you said you did not disagree with the substance of that article; is that right?

Dr. YORK. That is right. I agree with, I think, what was Senator Symington's observation. This is an excellent discussion of the subject.

MILITARY EFFECTS OF NUCLEAR TEST BAN DEPENDS UPON POLITICAL FACTORS

Senator YOUNG. Now, in open session, Doctor, what can you tell us of your personal views as to the military implications of the cessation of all nuclear testing?

Dr. YORK. What are my personal views on the military effect of the cessation of all nuclear testing?

Senator YOUNG. Yes. What is your judgment, in other words?

Dr. YORK. Well, even this question depends on political factors, such as would the Russians cheat or would they not?

If they don't, then quitting when you are generally ahead doesn't seem to me to offer an obviously disadvantageous alternative. I have said that a little bit backwards. But we are, I believe, well ahead in this particular field of weapons development. When you are ahead, if both sides stop, and really stop, it seems reasonable to me that this would leave a permanent advantage to us.

Now, the question of whether or not they would really stop when there is an official moratorium is a political question. I don't know what the propensity of the Russians is to live up to or not live up to this kind of thing.

Senator YOUNG. My view, Doctor, is that you have completely discussed your present judgment and have completely answered my question. But should you desire to amplify your answer in the record, after think it over later today, instead of me taking time for further questions, without objection you may do that.

And now, Senator Martin, have you any questions?

SOME OVERLAP BETWEEN MILITARY AND NASA SPACE PROGRAMS IS TO BE EXPECTED

Senator MARTIN. Dr. York, this is the Subcommittee on NASA Authorization of the Committee on Aeronautical and Space Sciences. We have before us H.R. 10809 that passed the House March 9, and has in it authorization for $915 million for NASA.

Of course we are interested in comparing what the Defense Department is doing in coordinating aeronautical and space matters. But I don't believe I will undertake to review the entire defense program at this time.

I want to ask a few questions particularly on matters bearing on the interrelationship between your program and the NASA program.

As I understand from your statement, you have over here on page 6 the military space systems funding—that is not part of the NASA authorization bill before us now.

Dr. YORK. That is right.

Senator MARTIN. It is entirely additional to what we are considering here.

I followed your prepared statement here with great interest. Your principal interest in the Department of Defense—and the Depart-

ment of Defense prime role in space is to use this new environment when it affords the opportunity to enhance the military effectiveness of weapons systems used in the four important roles of defense, offense, information and logistics. I have not anticipated this subcommittee getting into the defense and offense phases of your work so deeply. Your military space programs will overlap, undoubtedly, NASA activities in the field of information, and possibly in the field of logistics. That would be my concept of this. We are interested in what you are doing. But it is primarily to keep ourselves fully informed.

On page 4 of your prepared statement, you said, "In developing our current military posture on space systems, the Department of Defense initially directed its attention to those immediately achievable space systems that provided an improved extension of currently used techniques for obtaining military information."

VELA IS PRESENTLY NOT SPACE RELATED

And you go on and name the various programs. I notice that Vela is not listed in your table of military space funding items. That is the one you mention on page 4 of your statement—the nuclear test detection project. And I don't find an item included.

Dr. YORK. Yes. You have turned up an oversight here, Senator. It is not.

Now, what would you like me to do? I can discuss Vela very briefly right now.

Senator MARTIN. It aroused my curiosity as to just what you are doing in Vela.

Dr. YORK. Well, Vela, at the present time, is primarily devoted in the direction—the work is primarily in the direction of seismology and so on. This is a program for the purpose of monitoring test suspension. It is for the present time—we treat it as highly classified, as far as the details go. Next years' program is not at the moment settled. So that in 1960, while there is a substantial program, there is not much of it at the present time that is space related. In 1961, we are not certain of what we will do, And, therefore, it doesn't influence the numbers very much.

Senator MARTIN. We could expect it to be covered in a supplemental budget later on, as things develop; is that correct?

Dr. YORK. I don't know how we will handle that.

Senator MARTIN. There is no way to anticipate what it will be, but it is an open matter as of now?

Dr. YORK. Yes, I don't know how we will handle it.

SHEPHERD PROGRAM HAS BEEN COORDINATED WITH NASA

Senator MARTIN. Now, your program Shepherd, the ground based tracking system, of course, comes pretty close to our field. I wonder if you would care to discuss that. I don't ask anything not appropriate for open session——

Dr. YORK. Shepherd is a program that has been very carefully coordinated with NASA. The bulk of the DOD side of Shepherd has been devoted to developing methods for detecting nonradiating satellites, or uncooperative satellites, dead satellites, and so on. But it has

been—this is a program that has been very carefully coordinated with NASA from the very beginning.

Senator MARTIN. I notice that your defense funding list, on page 6 of your statement, shows only $18 million for the Shepherd program.

Dr. YORK. Yes.

Senator MARTIN. And in communications, Notus, $142 million.

Dr. YORK. That is what is carried in the present program; yes, sir.

Senator MARTIN. And there is no set figure yet on Vela?

Dr. YORK. No yet, no.

OVERLAP BETWEEN MILITARY AND CIVILIAN SPACE PROGRAMS DISCUSSED FURTHER

Senator MARTIN. I am trying to get an idea of how your appropriation requests overlap those of NASA, if they do overlap. And, of course, I can see that they could very logically overlap in the field of information.

Dr. YORK. We were using information in the operational sense of gathering information necessary for our defense, meaning to cover by that, not scientific information, but reconnaissance information, early warning information and so on.

Senator MARTIN. I see. Strictly a military venture.

Dr. YORK. Yes—not scientific information. To the extent we are in that field, it is covered by our supporting research.

Senator MARTIN. On page 4 of your statement, you stated:

> Two additional areas of research and development, not system oriented and treating with the broad research and development needs, complete in a general sense the key areas of military research and development directed toward space needs. These are:
>
> (1) General research and component development. This covers, for example, space maneuverable and recovery systems, guidance, control and navigation components, and rocket engine development.
>
> (2) Ground-based equipment. This covers, for example, space surveillance, tracking and control, environmental test facilities, and test centers.

I gather from that you do have some overlap, or are bound to have.

Dr. YORK. Yes. There are areas where the work is very similar, and therefore we have joint groups working to try to make sure that these programs complement or supplement each other, rather than just simply duplicate each other.

Senator MARTIN. To me, that is not exactly alarming. I think they have a role in relation to the bill we are currently considering in the Space Committee. We are trying to determine the authorization of $915 million for the National Aeronautics and Space Administration, as outlined in this general series of hearings. You have these sums listed here for military space programs totaling $407.1 million, plus $64 million for major space-related projects, making a grand total of $471.1 million. I am not at all surprised that that much money is needed in your field for the work you are doing that can be coordinated to a certain extent with the work NASA is doing. Our main emphasis in these hearings is certainly not national defense, or the military approach to this matter. We have a very real interest in NASA's program for the peaceful uses of outer space. We have some little interest with the UN's adventure in that field. Senator Dodd and I are the two Senators in touch with the State Department on that. We went through quite a realistic experience last year in trying to

persuade the Russians to join in on that adventure, and they boycotted up until December 13. While from the time they have joined it, they haven't exactly helped us advance very rapidly in the matter of achievement. I see my time is up now. I wanted to try to clarify how you coordinate your military space plans and NASA's plans, bearing in mind there is bound to be some overlap between them.

I think that is all I have.

Senator YOUNG. Senator Wiley?

Senator WILEY. Thank you, Mr. Chairman.

I am not a member of this subcommittee. I am a member of the committee. I have listened with interest to the testimony this morning. I just have two questions.

One relates to what has already been suggested, and that is the matter of the military and the civilian space programs—whether or not there is a collaboration there as between the two objectives and the people working in that field.

Dr. YORK. My answer is yes, there is.

DR. YORK SEES NO OPPORTUNITY FOR SAVINGS IN SPACE PROGRAMS

Senator WILEY. Well, now, if there is, the second question—there will be three of them—the second one is do you see any opportunity for a saving?

Dr. YORK. No important opportunity, Senator Wiley.

Senator WILEY. Do you think that someone that recognizes to a large extent the significance of these large sums of money couldn't do something, and yet still have effective results in both space and in defense?

Dr. YORK. I don't think that any important savings could be accomplished by another more thorough review than this has already been given.

Senator WILEY. In the last age of exploration, the nations got to fighting each other over territory, and so forth and so on. Have we got any real economic collaboration with our allies in relation to space, in sharing the costs of the rockets and in relation to preparing the weapons for defense?

Dr. YORK. Well, there are a number of important places where we cooperate with our allies. As far as the Department of Defense is concerned, these are in fields other than the space field, by and large.

IT MAKES SENSE TO COOPERATE WITH OUR ALLIES

Senator WILEY. Well, perhaps I didn't make my question clear.

We recognize, now that we have built up our allies, so that they are in a position to not only put themselves on their feet, but to make contributions in relation to NATO and other fields. Isn't it just commonsense that the brains of our allies and the brains of America get together to collaborate and that the expense incurred be borne equitably between the nations who are really interested in conquering space and developing defense weapons? Isn't it just commonsense that we get together? Or should we keep on spending our own money, and let them go ahead on their own and spend their money, and have duplication, and triplication, and so forth?

Dr. YORK. It makes sense to me that we should get together, Senator Wiley.

Senator WILEY. It would make sense?

Dr. YORK. It does to me.

Senator WILEY. Well, aren't you the chap that could tell somebody just what you have said now, that it would make sense to cooperate?

Dr. YORK. In the space programs, the international aspects of these space programs are in the civil space agency, Senator.

INTERNATIONAL COOPERATION IS MOST FEASIBLE FOR CIVILIAN SPACE PROJECTS

Senator WILEY. Now, of course, people might ask why I am interested in this. I am interested because the taxpayer is interested, and they feel now that our own domestic markets are being impacted by the manufactured goods of the countries that we have built up to compete with us, and whose economy is in fine shape—why shouldn't we get together literally and actually to find out all about space? Why shouldn't we really do it in the interests of, let's say, self-preservation?

Dr. YORK. I think we should, and I think that NASA is beginning to do that. But the types of programs that fall—that are most easily handled by international groups, in which international cooperation is most feasible, are those in the civilian space agency rather than the defense programs.

Senator WILEY. There isn't any monopolistic desire on the part of Americans who want to go into space, and not let our allies do so. Did you ever think there might even be an opportunity for our getting together with the Kremlin, so we won't be shooting ourselves to pieces?

Dr. YORK. That has been discussed by the people involved, yes, sir.

Senator WILEY. It has been discussed. And then the discussions stop?

Dr. YORK. Well, I am in the Department of Defense, and it is especially awkward to get together with the Kremlin on this program.

Senator WILEY. Thank you, Mr. Chairman.

Senator YOUNG. Mr. Lehrer?

DR. YORK DID NOT APPROVE GENERAL BETTS' SPEECH ON SPACE

Mr. LEHRER. Thank you, Mr. Chairman.

Dr. York, General Betts, the Director of the Advanced Research Projects Agency, made a speech last week, in which he made a number of statements with regard to our space program. Since General Betts is directly responsible to you, are we correct in assuming that his speech was approved by you?

Dr. YORK. No, I didn't go over his speech, Mr. Lehrer.

Mr. LEHRER. In that case, we would like to——

Dr. YORK. But I have general confidence in General Betts, sir. But I didn't go over his speech.

DR. YORK AGREES OUR SPACE PROGRAM IS MORE RATIONAL THAN RUSSIANS'

Mr. LEHRER. All right. I would like to read some of the pertinent statements General Betts made, and get your comments on them.

General Betts stated, and I quote:

Our greater hope lies in the growing evidence that we seem to be more intelligent about the use of space. While the Soviets seem to be going for splashy firsts related to their obvious advantage in large thrust levels, our program is more rational in terms of continuing payoff.

Now, since General Betts states that our program is more rational than that of the Russians, apparently we must have some idea of what the Russian program is. Would you tell us what the Russian program is?

Dr. YORK. Well, I don't know what General Betts had in mind. However, what we know is that in the last two and a half years, now, the Russians have launched only three satellites, the third one of these being just about 2 years ago. Then they launched a group of three lunar probes—well, deep space probes, one of which hit the moon, one of which went by, and one of which circled behind the moon. We know that in the case of each of these they got rather interesting results. It is a little odd that in 2 years they have not chosen to follow up on their earlier satellite programs. I don't understand quite why they have not done it.

RUSSIAN SERIES OF SPACE FIRSTS HAS INFLUENCED WORLD OPINION

Mr. LEHRER. In other words, then, when you say it is more rational, you apparently mean it is more rational from a United States point of view which stresses the scientific aspects of the program. Do you know, Mr. Allen, the Director of USIA, has stated that the Soviet series of firsts has had tremendous impact on worldwide opinion, and has seriously weakened the position of the United States in the eyes of many of the peoples of the world.

Dr. YORK. I don't know what you are asking me. I agree with Mr. Allen's statements, and endorse them wholeheartedly.

Mr. LEHRER. What we are trying to find out is what the basis is for comparison. In other words, do we have a basis for this statement?

Dr. YORK. Well, really, I think you ought to be asking General Betts what he had in mind. I can only guess, knowing him reasonably well, as I imagine you probably know him somewhat yourself. I think that he was referring to the fact that just looking at what the Russians have done, and this rather odd gap in running satellite experiments on their part, and looking at what we are doing, and what he knows about the systematic way in which NASA in particular is going about the exploration of space, because I believe that is what he was referring to more—perhaps he thinks that our program is a more logical and systematic development of the whole field, even if being—late it isn't at the present time—it hasn't at the present time produced certainly the spectacular results of the Russians.

You are asking me to psychoanalyze General Betts, and I can't quite do it.

MILITARY SATELLITE PROGRAMS ARE BEING PACED "PRIMARILY" BY TECHNOLOGICAL LIMITATIONS, NOT "SOLELY" BY TECHNOLOGICAL LIMITATIONS

Mr. LEHRER. All right. Referring to various satellite programs, General Betts stated—

In the judgment of many, they are being paced only by technological limitations, not by availability of funds.

Do you share this judgment?

Dr. YORK. Is he referring to our own program?

Mr. LEHRER. Yes, to the Department of Defense programs.

Dr. YORK. That certainly is true with regard to a number of our programs. Actually, they are being paced to some extent by both of these—by both technological information, background, and by availability of resources.

Mr. LEHRER. Let me be specific. General Betts referred to Samos, Transit, Tiros, and Midas, and said:

These programs are being actively pursued. In the judgment of many, they are being paced only by technological limitations, not by availability of funds.

Are these five programs that General Betts mentioned, in your judgment, being paced only by technological limitations and not by availability of funds?

Dr. YORK. I can't say only, but I will say mostly, primarily by technology. For example, no matter how much more money you put into Midas, it still is a numbers of years off, and there are things that have to be done that simply take time to do. And the reason you have to do them is because you don't know the technological base to work from right now. So that I agree with what General Betts has said—maybe not quite to the extreme there.

Mr. LEHRER. This is a very important matter. Let's take each of these programs in turn, so that we can be sure of what the facts are.

Now, let's take Midas first, which you have just mentioned. Is Midas being paced only by technological considerations at this time and not by the availability of funds?

Dr. YORK. It is being paced primarily by technological considerations.

Mr. LEHRER. Then, I take it, there are also fund limitations on Midas.

Dr. YORK. In any of these cases, if you put more money in, you could do somewhat more work. But in the case of Midas, you would be in the region of diminishing returns. That is, you would get less per dollar. And the reason is that the technical information isn't available on which to—which you can expand the program much beyond what it is.

Mr. LEHRER. All right.

Dr. YORK. So, primarily, it is being held up by technological problems.

Mr. LEHRER. Now, let's explore the reconnaissance satellite, Samos, is that being paced only by technological limitations, and not by availability of funds?

Dr. YORK. No, not only, but primarily.

Mr. LEHRER. How about Transit, the navigation satellite?

Dr. YORK. I think—I am not sufficiently familiar with that to be certain. At the present time, it is waiting for certain equipment to be built and launched, and it is probably not being paced by either at the moment, but just simply by getting the parts built, put together, and in orbit. I don't think it is being paced by either one right now.

Mr. LEHRER. Now, how about Tiros, the weather satellite?

Dr. YORK. That is a NASA program. So that I am less familiar with it. I don't know.

(NOTE: See p. 31 for description of successful launching of both Tiros I and Transit I–B subseqent to this testimony.)

COMMUNICATIONS SATELLITES ARE BEING DISCUSSED WITH JOINT CHIEFS OF STAFF

Mr. LEHRER. Let me shift to another area that General Betts covered. And I quote this statement:

> One of the great payoffs in the use of satellites lies in the possibility of a major increase in flexible worldwide communications. We are actively pursuing just such a development. But an effective system is years away. Of course, we could crash this effort and fly some kind of a real time repeater satellite in a year or so. It would provide some additional communications changes for a limited time. No doubt about it. But without reliable components operating in the best frequencies, it would just not make sense to put our operational money into such a rathole at this time. We will get to an effective communications satellite in good time, I am sure, but premature emphasis on flight testing would delay rather than speed up that time. There are some programs that go faster with less, not more, money, believe me.

Now, in earlier testimony before given at joint hearings of the Space Committee and the Preparedness Subcommittee, Generals Power and Schriever stressed the importance of communication satellites for SAC communications. And as you know, the Defense witnesses have all testified that our SAC bomber force is our principal strategic deterrent today, and will continue to be so for several years.

In view of the importance of communications satellites for the responsiveness of our SAC bomber force, why is the Department of Defense holding back on the development of an operational communications satellite?

Dr. YORK. There are quite a few versions of a communications satellite, of interest to different groups. A satellite whose purpose is connected with SAC control is only one. These are sufficiently different so that what we have found is that we are taking our resources and dissipating them in too many different directions. And we are right now trying to pull this program together.

I am right now in the process of discussing this with the Joint Chiefs, and I am not prepared to make any statements with regard to possible conclusions of this discussion.

SAC COMMUNICATIONS SATELLITE NOT FEASIBLE FOR SEVERAL YEARS

With regard to the particular question of its use in SAC, you remarked that SAC is the backbone of our deterrent now, and will be for the next several years.

The question of a communications satellite is not a question that says, Will SAC be useful or won't it? There are other communications means available for control of SAC. A communications satellite is a possibly somewhat better means, but it is not the only means. So that we are not dealing with SAC or no-SAC in this question.

Furthermore, a satellite whose primary use is to be in connection with controlling SAC at the outset of an intercontinental war is not a trivial system. I mean if you are going to have it, it has got to be absolutely reliable and workable. In other words, if you are going to use it for such a key problem as controlling SAC at the outset of an

intercontinental war, it has got to be very good. The state of technology is not such, in the opinion of many of us, to allow us to have within a few years—Iam not quite sure whether you and I both mean the same by a few—to have a useful satellite for control of SAC within a few years.

MIDAS PROGRAM WILL BE ACCELERATED IN FISCAL YEAR 1961

Mr. LEHRER. When General Schriever testified before this committee just a month or so ago, he stated that he hoped that a decision would be forthcoming shortly from the Department of Defense to proceed with Midas on a weapons system basis. Secretary Gates testified last week, and stated that this decision had not yet been made. Could you tell us what the status is on accelerating Midas, and proceeding with it on a weapons system basis?

Dr. YORK. With regard to accelerating Midas, it has been decided that Midas would be accelerated over the original—over the original plan as submitted with the President's budget.

The precise acceleration of this program has not been worked out in detail. As you know, in connection with the recent proposals of the Air Force for modifying its air defense program, and reprograming some of the funds made available by that modification, they propose to put some funds into this program.

In addition to the remaining uncertainties associated with that, and the problem of redistributing the funds within the three programs, SAMOS, Midas, and Discoverer, all the details simply have not been worked out. But it is definite, and the Air Force, the people in charge of the program, are well aware of this, that the program is going to be substantially increased in 1961 over what had been previously planned for 1961.

BOMARC CUTBACK WAS INITIATED BY THE AIR FORCE

Mr. LEHRER. Since you raise the question, could you tell us whether the cutback of the Bomarc program was the price the Air Force had to pay in order to get the funds to accelerate Midas and the other weapons systems?

Dr. YORK. The Air Force can testify best to that, because what is involved here are not—are not research and engineering matters, which are under my cognizance, but rather deployment and operational matters connected with weapons systems for the active antibomber defense. I believe that the burden of the Air Force testimony, however, is that a reconsideration of the air defense on its own led them to these conclusions, and, following that, they then determined what to do in the way of reprograming, rather than the other way around.

LANDING ON MOON WOULD HAVE GREAT INDIRECT IMPORTANCE

Mr. LEHRER. I would like to quote one final statement from General Betts' speech. He said, in concluding his speech:

Some day a man will step out of a spacecraft on the surface of the moon. Whether he is Russian or an American will have little direct military significance. But the prestige and other indirect effects associated with such an event are certainly important to our national security. Let's hope he is an American.

Do you agree with General Betts that there is little direct military significance, either now or in the future, to landings or bases on the moon?

Dr. YORK. Well, taking the whole sentence, I essentially agree with what General Betts has said. But certainly the latter part—I mean the effect of this landing, and who this man is—the indirect effects of this on the position of the United States, I think, is of very great importance.

The first man on the moon is not going to be able to claim the moon for whomever it is that sent him up there. So that the fact that he now occupies an extra square foot of territory somewhere, by virtue of standing there, I don't think is of direct importance.

On the other hand, the indirect influence of this is very great—the fact that it is indirect doesn't make it less important.

DEFENSE DEPARTMENT HAS NO PRESENT PLANS TO DEVELOP NEW LARGE BOOSTER FOR DYNASOAR

Mr. LEHRER. Yesterday, Dr. von Braun outlined to this committee the Saturn program. The question was raised as to whether the Saturn would be the booster for Dynasoar. It is Dr. von Braun's view that the Saturn is the only prospectively available large booster that could handle the Dynasoar. Yet in the Department of Defense letter to this committee, it was indicated that the phase which follows boosting unmanned and manned gliders with a Titan ICBM, will require larger boosters not yet defined. Now, does the Department of Defense have any plans to initiate the development of a large booster for Dynasoar that is any different from the Saturn?

Dr. YORK. At the present time, no. But it is possible that as we go ahead with the program, it will turn out that that would be desirable. But at the present time, no.

Mr. LEHRER. That is all, Mr. Chairman.

Senator YOUNG. Senator Cannon?

WE WILL WANT BOOSTERS LARGER THAN SATURN

Senator CANNON. Thank you, Mr. Chairman.

Do I infer from your last answer, Dr. York, that there might be the necessity to develop a larger booster than the Saturn?

Dr. YORK. That doesn't depend on my—the last question. But I think that we will want—nevertheless, I think we will want larger boosters than Saturn down the road.

Senator CANNON. Do you have any estimate as to how soon we might require or need a larger booster than Saturn?

Dr. YORK. No. I don't know how to put a time statement in regard to when you will require one. I think bigger boosters will turn out to be—I don't know whether to say very useful or essential—but one of those two, for true space exploration.

Senator CANNON. Well, now, Dr. Glennan stated a few days ago, before this committee, that Saturn would be operational before the end of 1964, and he then said that he doubted that the Soviet Union would exceed us in thrust capability after that time. One of the reasons given was that there probably would be no need for a booster of greater strength than Saturn, and that, therefore, neither they nor we

would be likely to be going ahead very fast in that direction. Do you agree with that premise?

Dr. YORK. It depends what they and we decide to do about manned exploration of space, in particular manned flight to the moon and the planets. If it is our intention, or it is the Soviet intention, to carry out a large-scale exploration program, then I believe it could be probably done more simply with bigger boosters than the Saturn.

DR. YORK SAYS IT IS A TOSSUP WHETHER SOVIETS WILL EXCEED OUR THRUST CAPABILITY AFTER 1964

Senator CANNON. Do you then agree or disagree—or do you have a view—as to whether or not the Soviet Union will have a requirement for a bigger booster than Saturn?

Dr. YORK. If they want to do what I described in my last answer; namely, carry out a large space exploration program, I think they would need a bigger booster. But they may not intend to do that. And, furthermore, that can be done with a booster of the Saturn size. It just becomes perhaps a more awkward way of doing it.

Senator CANNON. Do you agree that the Soviet Union will not exceed us in thrust capability after 1964, when we have the Saturn in the program?

Dr. YORK. I really don't know. I think of it as being almost a tossup, as to whether they will or won't.

Senator CANNON. In other words, we don't have any evidence now to support that statement, either that they would or would not?

Dr. YORK. It is a matter of judgment on the part of the people answering the question.

DR. YORK FEELS WE SHOULD BE, AND ARE, IN A SPACE RACE WITH RUSSIA

Senator CANNON. There have been a number of witnesses who have testified to divergent views as to whether or not we are in a space race with the Russians. Would you care to express an opinion on that, Doctor?

Dr. YORK. As far as the Department of Defense is concerned, we are engaged in a program to do what is necessary to have a superior defense, and that is independent of whether it is space, submarines, or what have you. It is a program designed to have the sum total of defense be adequate, and to the extent possible superior. But your question, I am sure, was related to space, and not defense.

Am I right?

Senator CANNON. Yes, it was related to space.

Dr. YORK. I think actually most—I read some of the disagreements, some people say it is a race, some people say it is a tough competition, and not a race. I can't help but feel this is just simply an argument about words, and that these people really do agree wtih each other, whether they choose to use the words "race" or "tough competition" or what. A race is a simpler word. I don't mind using it myself.

Senator CANNON. In other words, irrespective of the terms used, we are trying to better our relative position with relation to Russia, is that correct?

Dr. YORK. Well, I think we should be, and I think we are, yes.

NIKE-ZEUS CAPABILITIES ARE DOUBTFUL

Senator CANNON. Now, Doctor, when you testified last year, I remember we had a discussion concerning the Nike-Zeus, and you indicated that you did not have too great confidence in its possibilities at that time. Would you care to express yourself now, approximately a year later, as to the Nike-Zeus program?

Dr. YORK. Well, I still have considerable doubt about whether Zeus will do what it is supposed to do. On the other hand, that is an extremely important objective—I mean the objective of developing an active defense against missiles, and therefore as far as research and engineering is concerned, we are supporting in the Department of Defense a very large program, in the neighborhood of $300 million, whose purpose is to carry out—to continue the development of the Zeus system, and to carry out tests against—tests of the systems against realistic targets, as expeditiously as possible.

Senator CANNON. Well, now, having had the advantage of additional studies, and experimentation in this field, of at least a part of a year since you last appeared—do you have any greater confidence in the possibilities of the system as of now than you had when you appeared before this committee last year?

Dr. YORK. No. As far as its ultimate usefulness is concerned, I feel pretty much the same.

OPERATIONAL NIKE-ZEUS SYSTEM WOULD BE EXTREMELY EXPENSIVE

Senator CANNON. The Zeus, I believe, you indicated before, would be a tremendously expensive, tremendously costly system, is that true?

Dr. YORK. That is true. In order to have enough Zeus batteries to protect any reasonable fraction of the population of the United States, it would be an extremely expensive undertaking.

Senator CANNON. Would it be fair to say that it would require practically a ring of Zeus installations around our country, to provide effective coverage?

Dr. YORK. No, that is not enough, because Zeus is a terminal defense, and not an area defense. If you want to protect the entire area of the United States, then you have to spot these things over the entire area.

Senator CANNON. A ring around the country would not be sufficient.

Dr. YORK. A ring around the country would not be sufficient.

Senator CANNON. So that we are talking about great numbers of this weapon, if it proves out to be an effective weapon?

Dr. YORK. Yes. Well, it depends what you want to do. If you want to use it to defend just a few particularly valuable strong points, then, of course, it doesn't cost too much. If you want to use it to protect, say, that half of the population, the most concentrated portion of the population, you are already in the $10, $15, $20 billion class. If you want to protect the whole population, I don't know what it would be, but many times more.

Senator CANNON. Probably astronomical. Would that be a fair statement?

Dr. YORK. I guess pretty expensive, anyway.

NIKE-ZEUS DECISION MORE THAN A YEAR AWAY

Senator CANNON. Now, are you able to tell the committee in open session, approximately when you think the experimentation along the lines of the Zeus program will be far enough along to make a decision?

Dr. YORK. Well, if one waits for results and takes the time to fully analyze them, we are talking about, without going into any more detail—we are talking about more than a year.

Senator CANNON. I see.

I have no further questions.

Senator YOUNG. Dr. York, we appreciate very much your presence here. You have been questioned at length. Should there be anything further you wish later to insert in the record, to amplify any answers you have given, we will hold this open temporarily for that purpose, Doctor.

And now, are there any further questions?

You may be excused, then, for the time, Dr. York.

General Bernard Schriever, will you please step forward?

Do you wish anyone, General, to be seated beside you?

General SCHRIEVER. Colonel Boatman can sit here. He doesn't have to sit beside me.

Senator YOUNG. General Schriever, we are very happy you were able to arrange to be here in response to our investigation. As acting chairman of this subcommittee, I desire to express the appreciation of the entire subcommittee, and the entire committee in fact, because doubless you have made some sacrifice to rearrange your schedule, and may I express regret we had to keep you waiting for some time.

When we proceed with your testimony, General Schriever, we will go as long as you care to conveniently testify. You are our final witness and it is now 5 minutes of 12 and we may be able to conclude by 12:30 or about 1 o'clock at the latest. I feel that that would suit you better, rather than to return later—is that correct?

General SCHRIEVER. I will stay here as long as you want me, Senator.

Senator YOUNG. That is fine.

Will you stand and be sworn, please? This simply follows the custom of our committee.

Do you solemnly swear that the testimony you will give in this hearing will be the truth, the whole truth, and nothing but the truth, as you will answer to God?

General SCHRIEVER. I do.

TESTIMONY OF LT. GEN. BERNARD A. SCHRIEVER, COMMANDER, AIR RESEARCH AND DEVELOPMENT COMMAND, U.S. AIR FORCE

Senator YOUNG. You are Lt. Gen. Bernard A. Schriever, commander of the Air Research and Development Command of the U.S. Air Force?

General SCHRIEVER. Yes, sir.

Senator YOUNG. General Schriever, have you any prepared statement?

General SCHRIEVER. No, sir, I do not.

MILITARY AND CIVILIAN SPACE MISSIONS ARE DIVERGENT

Senator YOUNG. Well, may I, as acting chairman, then, advert to a statement of yours, and ask a question, which will afford you an opportunity, I believe, to make such remarks as you see fit.

On March 17, before the House Committee on Science and Astronautics, you stated that, and I am quoting now:

> Any sound consideration of our military and civilian space activities must give proper weight to their individual characteristics. The military and civilian mission in space, and their attending requirements do not merge into a single image. There is a clear divergence, a divergence which becomes immediately apparent when the nature of the military and civilian space roles and systems are examined and compared.

General, will you please elaborate on this point, so that the members of this committee can understand the nature of a divergence which you believe exists?

General SCHRIEVER. Yes, sir, I would be glad to.

I think one reason that a divergence has not been apparent to this date is that it has been necessary to use essentially the same resources, and by that I mean the facilities and the hardware available for both the military and the civilian space efforts during the past several years.

I think there is a divergence already in terms of the objectives that we have. The objectives of NASA are largely exploration and scientific in nature, while ours are aimed toward improving our defense posture.

I would like to state now a number of factors which I consider to be important in pointing out that the divergence will probably be more marked in terms of the kinds of resources, and again I am thinking about facilities and hardware that will be used in the next decade, anyway.

First of all, the numbers. The numbers of vehicles required for military purposes, and I am thinking now of warning, intelligence, communications, will be relatively large, in order to give us the coverage we need. On the other hand, I think that the numbers of vehicles used by the NASA will be relatively few, because they will be exploratory and scientific in nature, and will follow to some extent, at least, the pattern of the Soviet scientific program which to date has only launched six vehicles since October of 1957.

Next, in terms of life, and repeating the same payload—we are after long life, which means that we require a high degree of reliability. Our communications satellites and our intelligence satellites, our warning satellites we hope will operate unattended for many months. We know that this will take time to achieve. But this is our goal.

On the other hand, the scientific programs will be changing payloads almost from shot to shot, because as they achieve or obtain certain scientific data, they will be going out after other data. So there will be a delay between shots because of the development of the payloads themselves.

Ours, of course, will be largely repetitive. That doesn't mean that we will not be developing better capabilities in intelligence and warning, and so forth, but once we get a package that works well, we will be using that same payload package over and over and over again, with certain improvements as we go along.

Another thing—for military purposes, we require a simple and reliable system—simple to operate and simple to maintain. I think in the scientific fraternity, or scientific exploration, it is possible to have a very sophisticated and complicated machine, because for the most part engineers and scientists operate and maintain these systems.

Naturally our aim is to reduce the cost per launch, because we will be involved in many launches, as these systems become operational.

Again, on the part of NASA, I think the cost per launch certainly is a factor, but it is not as important a factor. They are after performance to achieve a specific exploratory or scientific objective.

Our systems, I think, are time oriented to a greater extent. I think it is very urgent that we improve our intelligence, our warning, our communications capability. And the sooner we can do it, the better.

Now, it is true that NASA's systems are time oriented to a degree if you agree to the fact that there is a race or competition with respect to prestige in the world. And I think there is.

So in that regard, they are also time oriented. But they are not time oriented in terms of survival of the Nation.

I think there is a high degree of urgency associated with military systems, which in my opinion required a bolder and perhaps greater calculated risk in achieving our capabilities earlier

The last item, I think, that—in the military we have a developer and a user and a supporter relationship. This means that when we develop our systems, we have to work with the eventual operator, and also with the agency that will provide logistic support. This is a very large and complex system, in the military, and it is necessarily so. While in the NASA approach, it will be more or less on a task group, or task force basis, as I see it.

So I think there is a great deal of divergence between the military program and the NASA program, as we go down the line timewise.

Senator YOUNG. As acting chairman of this subcommittee, I have noted that the chairman of our subcommittee, Senator Stennis, has been present, listening to the testimony.

Mr. Chairman, as you may have to leave on another matter shortly, have you any questions at this time?

Senator STENNIS. Well, I thank you very much, Mr. Chairman.

Suppose I yield, if I may, to Senator Cannon at this time? I am expecting my administrative assistant to call me any minute now, and I must see him.

Senator YOUNG. Senator Cannon?

Senator CANNON. I thank you.

NASA SPACE PROGRAMS SHOULD INVOLVE LEAST NUMBER OF FAILURES

General Schriever, I take it from your testimony that you believe that we are in a race with respect to the Russians, particularly so far as our prestige in the world is concerned. And you have indicated that perhaps we should have a bolder approach. Do you have any special things in mind that you would like to mention to this committee?

General SCHRIEVER. Well, really, when I said bolder approach, I meant also a greater calculated risk. I had in mind more the military program than I did the NASA program. I think it is extremely important, for example, for NASA to have the least number of failures, for example.

Senator STENNIS. Least number of what?

General SCHRIEVER. Least number of failures, because prestige is involved in this, whereas in the military we perhaps have to move a little faster, and have to accept failures in order to get there a little faster. This is a matter of judgment. You can't wait forever to flight test something. You have got to get going. You have to get the best ground program you can, but you can't polish everything to the last microinch before you fire. So I really had reference to a bolder approach as far as the military is concerned.

I am not familiar with all the details of the NASA program. It sounds to me like a very adequate program, going down the line.

GENERAL SCHRIEVER ADVOCATES BOLDER APPROACH TO MILITARY SPACE PROGRAMS

Senator CANNON. Now when you say we should have a bolder approach in the military, do you have any specific recommendations that you would care to advance in open session?

General SCHRIEVER. Well, could I state a little philosophy here?

Senator CANNON. You may answer it in your own way, General.

General SCHRIEVER. Well, I think in the nuclear rocket age that we are just beginning to enter, the world, of course, has become literally the size of a peanut. And, as a result, the element of surprise has become perhaps the most important factor that we in the military have to be concerned with. The reason for that, of course, is that the Soviets have intelligence on the United States. We don't have an Iron Curtain. Our democracy doesn't work that way.

They have proven themselves, I think, as an aggressor nation. They have the initiative. They have an Iron Curtain. It is very difficult for us to get all the information we need. Certainly they have a great advantage in gathering intelligence.

They have been in the last 4 or 5 years in much of their military literature talking about preemptive war.

Now, what we need to do is to decrease the element of surprise to the very greatest extent possible. And we, of course, can do this by improving our intelligence, improving our warning, and improving our communications systems so that we can make decisions faster. Decisions in the future, if they are to be worthwhile in a war situation, will have to be made in a matter of minutes, and not days.

Now, all of these things are very, very important to us to do in the United States, and they can all be done with systems that operate in space. The Samos and the Midas are two examples, the communications satellite is another.

At the same time, because of the advantages enjoyed by the Soviet Union, similar systems are not particularly important to them. And I, for one, believe that this is one reason that they have not conducted a space program leading to systems of this kind. At least, they don't appear to have.

INTELLIGENCE, WARNING, AND COMMUNICATIONS SATELLITES SHOULD BE MADE OPERATIONAL WITH GREATEST DEGREE OF URGENCY

So, in my opinion, the importance of getting these systems operational to the United States is just overriding. And I think we should

put the greatest degree of urgency in getting these particular systems, the intelligence, warning, and communications systems, operational.

Senator CANNON. Now, are we doing enough at the present time, in your opinion, to improve those three systems you have mentioned—namely, the intelligence, the warning, and the communication satellite—or do you have certain recommendations that you would care to make by which we could improve the progress in these fields?

General SCHRIEVER. Well, No. 1, there has been a rather lengthy study and discussion and analysis of these systems over the past year or so, I would say that from and R. & D. standpoint, from a development standpoint, we are moving about as fast as we can move. In other words, they are being supported to the extent that our technology at the moment permits.

There are many different judgments as to how soon we can achieve certain major development objectives, and based on these judgments, rides the decision as to whether or not you initiate an operational weapons system program.

Now, if you wait until you have achieved those development objectives, and then proceed with an operational program, you simply add several years to the time cycle.

Now, there is under very active consideration, as Dr. York pointed out in his testimony, the moving into, say, an operational category on the Midas. The Midas and Samos are related, and there is consideration there as well.

I, for one, am not in agreement with some of the opinions with respect to these systems concerning the time that we can reach an operational capability. I think that the importance of these systems warrants a relatively high degree of calculated risk. I hope that decisions will be made along those lines. But they are under consideration now.

Senator CANNON. In other words, the importance of the objective is strong enough that the calculated risk should be taken of commencing with construction, even though the R. & D. phase has not been completed. Is that what you are saying?

General SCHRIEVER. Well, this is what we did in the ballistic missile program. As you know, we started our operational bases even before we flew the first Atlas missile. You just have to have faith that you are going to achieve your development objectives on a schedule or reasonably close to a schedule that you lay down.

Senator CANNON. You have mentioned Midas and Samos. Now, are there other systems that you think we should review with that same philosophy?

General SCHRIEVER. I think the communications satellite is essentially in the same category. They are all related. Your warning doesn't do you much good unless you can get it to the place of decision almost instantaneously. And so the communications satellite program has tremendous potential in improving our communications capabilities.

NIKE-ZEUS SYSTEM DOES NOT IMPRESS GENERAL SCHRIEVER

Senator CANNON. Now, General, I recall that some time ago you indicated that you didn't share this same view of a calculated risk in-

sofar as the Nike-Zeus program is concerned. Would you care to comment on the Nike-Zeus program?

General SCHRIEVER. Well, I certainly don't feel that I should comment in detail here, because I am not an expert on the Nike-Zeus program. During the period that we—that I had command of the Ballistic Missile Division, we did analyze and evaluate the various systems under consideration in terms of our own offensive capability with ballistic missiles, in terms of any countermeasures which we might introduce.

All I can say, I was not very much impressed with the Nike-Zeus system as one that would be very effective against the ballistic missiles that we were developing, and the countermeasures that we could introduce.

Senator CANNON. Let me ask you this. Do you think that there is any effective defense against ballistic missiles under study at the present time that could not be thwarted by the ballistic missile itself and the countermeasures which are now known to exist?

General SCHRIEVER. There are several different approaches in the study phase with respect to defense against ballistic missiles. And I want to make it clear that I think that the nation that develops an effective active defense against the ballistic missile will have a major breakthrough in the defense picture. So I am not fighting the problem. I would like to see the United States develop a defense system against ballistic missiles. At the moment, there are none that I know of that have sufficient promise that we should proceed into a large-scale hardware program.

THE UNITED STATES SHOULD ACHIEVE SPECTACULAR SPACE FIRSTS

Senator CANNON. Now, you have indicated that in order for us to regain our prestige, or improve our prestige in the world vis-a-vis Russia, that NASA, for example, should have the least number of failures, whereas in the military the problem is a little different. Would you care to comment on any of these so-called spectacular firsts? Do you think it is important that this country try to achieve some spectacular firsts, such as Russia has achieved in the past?

General SCHRIEVER. There is no question about it.

Senator CANNON. What about the man in space program, the Mercury program? Would you care to comment, insofar as that program is concerned, as to the possibility of this country having a first in that area?

General SCHRIEVER. I think there is a possibility there. It is intuitive on my part. It is based on, I think, first, that the NASA Mercury program, I believe, is being extremely well run. Secondly, at least the known firings of the Soviet Union don't necessarily indictate to me that they are moving fast toward putting a man into orbit.

WE DO NOT HAVE AN EFFECTIVE BALLISTIC MISSILE DEFENSE SYSTEM THAT SHOULD BE PURSUED TODAY

Senator CANNON. I have before me, General, a very recent article, in "Missiles and Rockets," by Mr. James Fusca, and I read part of this to you.

Results of a search for effective methods of defending the United States against attack by the sophisticated ballistic missiles of 1970–80 era, including investigation of such weapons as antigravity, antimatter, and the so-called death rays of science fiction, indicate that no promising approach exists within the bounds of present-day scientific knowledge.

This article goes on to state that a 12-company program sponsored by ARPA finds today that science has no answer to this problem. Are you familiar with that article, General?

General SCHRIEVER. I am not familiar with the article.. I am familiar with the ARPA project. All I can say is that there are some interesting and novel approaches which I don't think should be ruled out at this particular time.

Senator CANNON. But do you agree that at this time there is actually no promising approach that exists within the present-day scientific knowledge?

General SCHRIEVER. I think that some look reasonably good. But I don't believe we have analyzed them sufficiently to see what holes they might have. And this is going on, and certainly additional experimental work will be required. I would say that today you could honestly say that we don't have a system which looks as though we ought to go charging forth on.

WE SHOULD REDUCE THE VULNERABILITY OF OUR DETERRENT AND DECREASE THE ELEMENT OF SURPRISE

Senator CANNON. A few days ago, Dr. von Braun, in testimony before this committee, stated that he felt that we were not taking Russia seriously enough in a number of areas. I asked him what he considered to be the most important things, as far as this country was concerned, and his answer was first that he thought we were not doing enough in the educational field, and, secondly, we were not doing enough in our overall defense program, to protect us insofar as the future safety and security of this country is concerned. I am wondering if you share those views.

General SCHRIEVER. Well, I am not an expert in the education area. I do know that we have a very severe problem in obtaining and retaining the qualified people in the service, for example, at the proper educational level. Being commander of ARDC, this is one of my great problems. I have not been in this job long enough to have gone into a detailed analysis of it from a management standpoint. I would generalize that I would like to see more done in the educational field. As far as defense is concerned, I don't know exactly what Dr. von Braun has reference to. I think the most important two things, at least for the next few years, is to do everything possible to reduce the vulnerabilty of our deterrent strike forces, and, secondly, to decrease the element of surprise. These two things, I think, are the most important things ahead of us, so that we retain, as a minimum, a stalemate in our deterrent posture.

Senator CANNON. You have already indicated that we could be doing more to decrease this element of surprise. I wonder if you would care to state in open session whether or not you feel we should be doing more as far as the deterrent problem is concerned?

General SCHRIEVER. I feel that one area that I am not qualified really to speak on in detail is the air alert. This is a matter of timing,

and the judgment is not for me to make from where I sit. The other things, of course, that have great promise in reducing the vulnerability of our deterrent strike force, are our ballistic missiles, which include Atlas, Titan, and Polaris, and to a lesser extent the few IRBM's that we have overseas.

Senator CANNON. Do you feel we are moving fast enough on the Polaris, the Titan, and the Minuteman programs, General?

General SCHRIEVER. Well, I have not had the opportunity to sit in on all of the sessions and consider all of the factors that have a bearing on whether or not we have an adequate deterrent force when you take into account all of the elements of our military strength. And I would prefer not to get into details on that one.

Senator CANNON. Thank you very much, General.

I have nothing further now, Mr. Chairman.

Senator YOUNG. Senator Martin?

Senator MARTIN. General Schriever, the statement you have made, as quoted to you here a moment ago by Senator Cannon, seems to me to strike a very basic comparison between the military and the civilian space activities. You are following a very sound analysis of the situation, as I see it, in that statement that Senator Cannon stated or quoted.

NASA IS COORDINATING ITS PROGRAMS WITH THOSE OF DEPARTMENT OF DEFENSE

I have a question to ask about your own problems. Are you having any problems coordinating your space programs with those of NASA at the present time?

General SCHRIEVER. No. I would say we are not. We have been in a learning period, of course, during the past year. And I have actually established in my headquarters a special assistant to me on NASA matters. And we work very, very closely with NASA, both on a formal and informal basis, and also at the lower working levels. We have a number of Air Force officers that are actually assigned to NASA, General Ostrander being one. There are several others over in NASA headquarters. We have a number of Air Force officers who are working directly on NASA projects. We are, of course, as you know, supporting NASA in the Mercury program. The Pioneer V is another project in which the Air Force supported NASA.

I would say that we are working extremely close together, and I wouldn't want to paint a rosy picture that there are never any problems. There are always problems. There are problems within an organization. But I would say that we have made great progress in the last year, in establishing both policies and procedures in working together with NASA.

Senator MARTIN. I am glad to hear that. That was my impression from previous statements you have made. I am glad to have that assurance.

General SCHRIEVER. I personally know the people over there over many years myself, Dr. Dryden, Richard Horner, and the Air Force people. So this also helps in getting along.

Senator MARTIN. Do you find anything in the present Space Act which inhibits the Defense Department from carrying out mililtary space programs?

General SCHRIEVER. You mean in the House bill?
Senator MARTIN. In the Space Act.
General SCHRIEVER. The present Space Act?
Senator MARTIN. Yes.

DEPARTMENT OF DEFENSE COULD OPERATE UNDER PRESENT SPACE ACT

General SCHRIEVER. Well, I have testified before the Brooks committee, of course, on the bill that they have under consideration, and my statement there was that the proposed bill would eliminate certain confusions, although I feel that we could operate under the present act. I think that while we have operated, there have been certain problems. I think the proposed bill, over in the House, would improve the situation.

Senator MARTIN. That is all.

Senator YOUNG. Chairman Stennis, have you some questions?

AIR FORCE INFORMALLY DISCUSSED PROGRAMS INVOLVED IN NASA 10-YEAR PLAN

Senator STENNIS. Just a few, Mr. Chairman, thank you.

General, we have had Dr. Glennan here, and he showed us some charts and testified about the NASA program and how it was planned to be developed over the years. I believe he called it the 10-year plan. Now, I am more and more impressed with the intimacy between the developments that NASA might make and those the military might make, and the interrelation between your problems and their problems.

I wonder how far you were consulted, or the Air Force was consulted, with reference to the formulation of NASA's 10-year plan.

General SCHRIEVER. Well, we were not—at least at my level we were not consulted formally. But in working out their 10-year plan, we have had many sessions with them, particularly out at the Ballistic Missile Division on the west coast, where the bulk of our work with respect to space boosters is done, as it relates to the ballistic missile program, and our military program, such as Samos, Midas, and so on.

So I would have to say that we were not consulted formally, but we have had many, many informal conferences with them at working levels.

Senator STENNIS. Well, are you familiar enough with it, or do you know enough about the formulation of NASA's 10-year plan to say that at least it is not contrary to any plans you have? In particular, does it coordinate with your general objectives for military space programs?

General SCHRIEVER. Yes, sir. I am not familiar with every detail of their plans. But I know generally their booster program, their second-stage, third-stage developments. For example, they are using our Agena B program. They dropped their Vega program. They have the Centaur. We will be using the Centaur as it comes along. And these actions have been well worked out and coordinated between us.

We have had meetings on the Saturn with respect to its possible use with the Dynasoar during the later phases of Dynasoar. No defi-

nite decisions have been made, because we don't have anything beyond phase 1 of the Dynasoar at the present time, which is an experimental vehicle in nature, similar to the X–15, really. But we certainly will work closely with NASA on any followon with respect to the Dynasoar, for example.

THERE IS NO LACK OF COOPERATION BETWEEN NASA AND DEFENSE SPACE PROGRAMS

Senator STENNIS. Well, we like to feel that you gentlemen are trying to coordinate your efforts as well as conserve your money—that is, the money that is appropriated in these programs.

Is there any conflict or any program that is being retarded as between the two of you, due to the lack of cooperation?

General SCHRIEVER. I don't know of any. You take a look at the vehicles they are using in their programs. Most of them have come out of the military programs. As they go on, they will have some of their own. We have had some problems but we have worked out detailed operating procedures. Let's take one example. I will just give one.

That is working out what we call launch stand loadings at the Atlantic Missile Range. Now, we have the Atlas stands down there, and we had four of them. As you know, the Atlas booster is being used for the Mercury, it is being used for the Centaur, it is our Atlas ICBM, and it is being used for the Midas. We had a lot of problems in trying to work out a proper stand loading so that we could meet our objectives and they could meet theirs.

We finally set up a two-man committee, one man from BMD, one man from NASA. They sat down and worked out a stand loading, a very short policy statement, procedure, they worked out a coordinated program. These things change. They get back together and work it out. It has not come to my attention once since we have done that.

Senator STENNIS. Those illustrations are encouraging.

Have you had a similar experience with reference to laboratories, using laboratories in common, or the work of laboratories? Do you use their wind tunnels? They use your wind tunnels, do they not? I think the public would be interested in learning more about instances.

General SCHRIEVER. Yes, sir. I can't give you the details there, but they have used our wind tunnels down at the Arnold Engineering Development Center. We, in turn, have used theirs. And, of course, we have a long-standing relationship with them in this area.

AIR FORCE HAS A LONG-RANGE MILITARY SPACE PLAN

Senator STENNIS. All right.

Getting back to this plan, now, as outlined here by NASA, do you have a comparable long-range plan—whether it is 5 years or 10 years—for your planning?

If you have such a plan and can discuss it in open session, I wish you would give the highlights of it.

General SCHRIEVER. Our plans are somewhat different. I am talking now about an Air Force plan. I cannot give it in open session, but I can describe, I think, what our plan is like, and the difference between ours and the NASA plan.

We have a long-range plan which set forth certain development objectives. For example, we would like to reduce the cost of our launches. We would like to get greater simplicity, greater reliability, things of this kind. We want to improve our guidance capability, and so forth.

Now, we have a document, and I have a copy of it here, which is about so thick, which sets forth our development objectives. It starts—actually, it starts with our programs, our programs as of now. Then what we think we can do in the way of growth potential with those programs. And then a technical development program which appears to us to give us the greatest potential for improving defense capability in space. These are largely technical programs in nature.

Now, they are not all approved. This is a plan. It changes. But it is a long-range plan. And if you should like, we would be very happy to present it to you in a closed session.

B–70 DEVELOPMENT REPRESENTS A NEW PLATEAU

Senator STENNIS. All right. We might get back to that later.

I want to ask you just a little about the B–70. I don't know whether you are personally involved in the decision about the B–70. We all know pretty generally about the decision made in connection with the fiscal year 1961 budget to cut the program back to the development of two prototypes. Are you involved in the decision as to whether or not that will be continued? I am impressed with the fact that the B–70 represents a new plateau, a new supersonic bomber that could open the door to speeds far beyond that of the B–70. It concerns me greatly that this is being held back. Would you comment on that. Or is it entirely beyond your sphere?

General SCHRIEVER. The decision that was made was beyond my sphere. It was made at a higher level. The contribution or participation of the Air Research and Development Command is in the technical area.

In other words, we are responsible to submit to the Pentagon our best evaluation of the B–70 from a technical point of view. And this of course we have done in relation with our contractors. But it all comes through the Research and Development Command.

Now, I share your feeling, that it is a new plateau. I feel that the manned airplane will continue to be a part of our overall force. I think we should develop a mach 3 airplane.

As I earlier indicated, I think it is a mistake to put all our eggs in any one basket, because should, say, a defense be perfected against ballistic missiles, should a breakthrough be made in detecting submarines, for example, certainly we cannot rule out these possibilities.

So we need to have a diversity, and it is a question of the fact there are so many resources, and there is a question of course as to which way you go. But I think there is a very definite requirement that we have a diversity.

WE ARE TAKING A CHANCE IN STRETCHING OUT THE B–70

Senator STENNIS. This being a new plateau, and the prospect of it being a very important one, don't you think we have taken a rather

long chance to defer the B–70 program, even to the extent that we have?

General SCHRIEVER. Well, I would of course personally like to see it proceed and proceed at a fast rate; yes, sir.

Senator STENNIS. I am sure you would. I don't want to embarrass you or press you. But I think that we ought to know more about how much of a chance we are taking on that very point.

General SCHRIEVER. Well, I think, there is a matter of judgment here. I think that unless we do have a rather rapid breakthrough—and you never know, but certainly right today, sitting here, I don't know of the breakthrough of an effective act of defense against ballistic missiles. Nor do I know of any breakthrough in detecting submarines and so forth.

So I think it is a matter of judgment here as to whether or not you can afford to stretch things out.

Senator STENNIS. Let me be sure I understand your viewpoint. You do consider this stretchout of the B–70 to be a very major point, and you do feel that we are taking some chance by deferring it, as is now planned, is that right?

General SCHRIEVER. I think that is right, yes, sir.

Senator STENNIS. The question of the amount of chance is a matter of judgment, as you said.

General SCHRIEVER. Yes, that is right.

AIR FORCE 10-YEAR PLAN TO BE SUBMITTED TO THE COMMITTEE

Senator STENNIS. On your long-range Air Force space plan that you referred to a few minutes ago, could you later, for the record, supply us with an unclassified version of this plan?

General SCHRIEVER. Yes, sir, I think we could do that.

Senator STENNIS. Well, I wish you would.

Senator YOUNG. Will you do that?

General SCHRIEVER. Yes, sir, we will try to do that.

(The following statement was subsequently furnished by General Schriever:)

With respect to your request for an unclassified paper on Air Force space development planning, I have had my staff make a detailed review to determine whether or not a comprehensive or meaningful presentation could be made in an unclassified form. I am convinced that due to the fact that this subject involves vital and essential elements of national defense and deterrence, it is not possible to present such information without including highly classified material. Accordingly, I am forwarding to your committee staff, under separate cover, a classified discussion of Air Force space development plans.

MIDAS PROGRAM HAS BEEN ACCELERATED

Senator STENNIS. Now, one more question about the Midas. I wasn't here when it was brought up earlier today, but I understand that Dr. York discussed the question of accelerating the Midas program. Has that already been firmed up? Have you been given formal notification on that?

General SCHRIEVER. Yes, sir, there has been a definite setup of the Midas program since I last testified before the committee. The decision as to whether or not you classify it as an operational weapons

system, which means that you concurrently start doing things in the operational area too has not yet been made.

Senator STENNIS. That was going to be the second half of my question. There has just been a step-up in the development stage, but there has been no decision yet made about the going into the weapons system?

General SCHRIEVER. Well, I think there certainly has been a decision made that we will proceed with a development program leading to a weapons system. But I think that the judgment—the decision really is a judgment on when you will achieve certain development objectives, so that what date can you become operational really is what it boils down to.

Senator STENNIS. That is the next question.

General SCHRIEVER. Yes, sir.

Senator STENNIS. And are you willing to put an estimate on that now, or can you put an estimate on that?

General SCHRIEVER. Well, I can't in open session. But we have made our recommendations to the Department of Defense—that is, the Air Force has.

Senator STENNIS. All right. I believe that is all, Mr. Chairman.

Senator YOUNG. General, I have one question, and Mr. Lehrer has several questions. By going ahead with my one question, and the few questions Mr. Lehrer has—Senator Martin has informed me he has no further questions—then we will be able to complete your testimony this morning, and it will not be necessary for you to return in the afternoon.

General SCHRIEVER. Thank you.

NASA OFFICE OF LIFE SCIENCES COULD DUPLICATE MILITARY MEDICAL RESEARCH

Senator YOUNG. My question is this. NASA has just organized a new Office of Life Sciences to do research in space medicine. Now, General, is that not a duplication that will cause additional expense to our taxpayers, an absolute duplication of the Air Force biomedical research activities?

General SCHRIEVER. It could be. I have discussed this with Mr. Horner. We are going to have some meetings. It depends entirely to what extent and what degree they build this Office up. I know that at least it is not his intention—I have not talked to Dr. Glennan about this—it is not his intention to duplicate. I think they need to have an office. But I think it should be essentially a staff element, and not try to duplicate all the laboratory and other facilities and resources that we have in the military.

Senator YOUNG. But you do have a very adequate Air Force medical research activity, and you do believe that that should not be duplicated, do you not?

General SCHRIEVER. I certainly believe that. I think we need to expand ourselves to some extent.

We have to have it in the military. We have to marry the man to the machine. And we simply have to have it.

Senator YOUNG. Do you believe it would be far cheaper and more effective if you were permitted to expand your medical research ac-

tivities, rather than have NASA duplicate your facilities and activities?

General SCHRIEVER. I think so. Of course, we are supporting NASA now in the Mercury program, and so is the Navy for that matter. The Navy has certain capabilities in this area.

GENERAL SCHRIEGER HOPES TO MEET COMPRESSED TITAN AND MINUTEMAN SCHEDULES

Senator CANNON. General, can you tell us the status of the Titan and Minuteman programs, or would that be a matter for closed session?

General SCHRIEVER. I can say that we have had in the last few weeks three very successful flights with the Titan, which I feel very confident has gotten us out of difficulty, and we will be able to meet the operational schedules that we have laid down for it.

The Minuteman is on a very compressed schedule. I cannot give you in open session the exact operational dates. We have had some little difficulty in the large booster first stage, but we have had several successful runs here just in the last 10 days, so we are still hopeful of making this compressed schedule.

Senator CANNON. Thank you, General.

GENERAL SCHRIEVER'S VIEWS SUMMARIZED IN SPEECH ON "THE MILITARY ROLE IN SPACE"

Mr. LEHRER. General Schriever, on March 10 you made a speech to the national flight propulsion meeting of the Institute of Aeronautical Sciences, and the title of the speech was "The Military Role in Space." Does this speech summarize your views on the military role in space?

General SCHRIEVER. Well, I think it does. I don't know that I got everything in it that I wanted.

Mr. LEHRER. With the permission of the chairman, the speech will be placed in the record, and that will thereby save us asking a number of questions.

(The document referred to is as follows:)

ADDRESS BY LT. GEN. B. A. SCHRIEVER, COMMANDER, AIR RESEARCH AND DEVELOPMENT COMMAND, TO THE NATIONAL FLIGHT PROPULSION MEETING, INSTITUTE OF THE AERONAUTICAL SCIENCES, CLEVELAND, OHIO, MARCH 10, 1960

THE MILITARY ROLE IN SPACE

Ladies and gentlemen, it is a pleasure for me to be with you this evening and I welcome the opportunity to attend this meeting of the Institute of the Aeronautical Sciences.

Tonight I will talk about the military role in space and, to a lesser degree, its relationship to the NASA program.

In the last few months, as we all know, there has been nationwide interest in both the successes and setbacks of our missile and space programs. This subject has been, and continues to be, a matter of considerable debate in the Congress. It has been, and continues to be, a topic for speculation and opinion by our editorial writers, journalists, and commentators. In a democracy this sort of interest is both proper and necessary—and quite in keeping with the basic, and the best, precepts on which our country was founded.

I feel that it is of greatest importance for the Nation to reach an early understanding of the unique roles and missions, and requirements, of NASA and the Department of Defense. Our thinking on the subject of space becomes clearer when we realize that there are two distinct problems and two different,

though related, programs underway to solve them. One is the task of making, and keeping, the United States secure against missile and aerospace warfare. The other is our competition with the Soviet Union for prestige among the nations of the world through space projects that add to the sum of human knowledge.

Both are of great importance. Each has an effect on the success of the other. But they are not the same program, and the extent of our progress in one is not necessarily a sound measure of our advancement in the other.

My own interest and concern in space activities, quite naturally, is that which is seen from the eyes of a military man, whose first responsibility is the development of an aerospace deterrent strength sufficient to prevent any armed assault on our Nation.

It is axiomatic that there is no longer safety in distance on earth. We are literally next door neighbors to all peoples—and to their governments—whether they choose to live with us in hostility or in friendship.

The advent of megaton-yield nuclear weapons, of supersonic airplanes, of ballistic missiles, and the space age, has caused the world to shrink in terms of time to a mere fraction of its former size. This compression of the time factor has given a new and ominous definition to the element of surprise. For the first time in the short history of our Nation the United States is open to a destructive surprise nuclear attack. This change has had a revolutionary effect on every aspect of our national life—on our thought and behavior habits, on our trade, our political activities, and most of all on our basic feeling of security.

For example, an aggressor nation having complete target information and military forces armed with nuclear-tipped ballistic missiles will enjoy a new and formidable advantage. Under these conditions, our own deterrent posture must be one in which, first, the vulnerability of our offensive force is reduced to the maximum extent possible; and secondly, our warning and surveillance systems must greatly reduce the possibility of a surprise attack; and thirdly, our communications or command and control systems must provide the capability of making decisions in a matter of minutes.

These are cold, hard facts that must be acted upon and not just theories to be contemplated.

Well, what can we do about it? First, there are things that can and are being done to reduce the vulnerability of our offensive forces. This is air alert for our bomber forces. There is hardening, dispersal, and mobility being built into our missile forces.

We must have these forces in sufficient quantity to enable those surviving an attack to counterattack and win. These are actions generally agreed to, and understood by, the American people.

No so well understood, however, is the importance of surveillance and warning in eliminating the possibility of surprise attack. Nor is there a clear understanding of the need and nature of the command and control systems required to speed our national decisionmaking. Even less appreciated is the significant contribution which can be made by space vehicles toward the attainment of these objectives.

Now, why are these capabilities, for surveillance, warning and communication, of such great importance to the United States, and of little relative value to the U.S.S.R.? As I have already said, an aggressor nation, with superior target information, has a tremendous advantage in our nuclear-rocket world of today. Our national policy, which has been supported by our actions, firmly establishes the United States as a nonaggressor nation.

The opposite is true of the U.S.S.R. Certainly then, it is obvious that the nation which requires warning against attack is the United States—not the U.S.S.R. Here, space vehicles can play a most vital role.

One such system under development is the Midas satellite program to detect missile firings by the use of infrared sensors. Warning of this kind is very rapid, and therefore is of great value. However, our command and control systems must permit immediate dissemination of such a warning. Our present communication systems are not quite good enough.

Here again, the potential improvement inherent in space systems; namely, communication satellites, can be expressed in orders of magnitude. In short, adequate and reliable communication between globally dispersed land, sea, and air forces is possible through space vehicles. This will permit us to exploit our warning to the fullest, even if the time is only 15 to 30 minutes in length. An enemy, knowing that he could not achieve surprise, would certainly be reluctant

to attack. Thus, warning and communication satellites would greatly enhance the deterrent posture of the United States and the free world, while they would be of little military value to the U.S.S.R.

Now, in the field of military intelligence, the U.S.S.R. has no problem. It can easily assess the strengths, weaknesses, and intentions of the United States and the free world. In peacetime, because of our democratic principles, only our most vital technical information can be kept secure. And even here, we have not always fully succeeded. On the other sand, the Iron Curtain has been extremely effective.

The advantage of reducing this asymmetry in intelligence is obvious. Again, space vehicles, in the form of surveillance or observation satellites, possess the greatest potential to accomplish this objective.

In support of what I have just said, I would like to quote from a study recently released by the Senate Committee on Foreign Relations.

Speaking of the prospect for the military use of earth satellites, the authors declare, and I quote: "There is one obvious reason for considering whether these vehicles may alter the military balance. It has been suggested that the present nuclear-missile generation may, in a later stage, be conducive to a qualified form of strategic stability when the strategic weapons of both adversaries are predominantly composed of missile systems that are relatively secure from attack. But let us suppose for the moment that the majority of U.S. retaliatory missile installations become known to the Soviet Union, while only a few of theirs are known to us. Let us presume further that the anticipated mobile missile systems, such as the submarine-mounted Polaris and railway-borne Minuteman, turn out to be less secure from attack than is now hoped to an enemy who has access to the quality and quantity of military intelligence available in our free society. In these circumstances it would be extremely difficult for the United States to develop a relatively secure strategic force. But a really effective surveillance and communication satellite network might offset the Soviet intelligence advantage in this respect, with consequences so profound as to credit the satellites with introducing a new weapons generation."

Now it appears to me that as a minimum, we must achieve the "qualified form of strategic stability" referred to in this report. Our deterrent posture may be dangerously inadequate, if the strategic equation should become unbalanced in favor of the Soviet Union.

I would now like to discuss briefly certain general characteristics of space as applied to the military and to NASA.

The applications of space to military purposes put an emphasis on certain features which are not required for the scientific exploration of space.

First, for military space systems, continuous operation is usually essential. A satellite warning system or a military communications system is worthless if it is not available at the unpredictable instant of need. Hence, the satellites must be redundant and vehicles must be ready to launch replacement satellites whenever a failure occurs. Next, most military systems require relatively large numbers of satellites to obtain the required coverage. This requires that for military space systems the cost per launch must be held down to acceptable values. Finally, the units must have a simplicity of operation that will permit use by military crews rather than very specially qualified groups of engineers, and they must have the high reliability necessary to achieve the military mission. In these respects they differ significantly from the vehicles which can be used for lunar and interplanetary unmanned exploration. For the latter type of scientific data-gathering, relatively few vehicles of maximum performance flown relatively infrequently can contribute enormously to our store of knowledge.

With each successful mission the usefulness of a particular type of payload may be concluded. The launch rate will therefore have to be slow in order to provide time for development of payloads and equipment for the next objective. This has been characteristic of the Soviet program. With the slow launch rates, maximum performance rather than minimum cost for launch tends to be the criterion. This leads to an emphasis different from that needed for the development of military space systems.

Looking a little further into the future the Department of Defense will need a number of improved orbital systems of various types in the coming years. It will also have a requirement for more thrust, so that the systems can carry a greater weight of military equipment. Eventually too, we will place pilots and observers in them—there are many activities for which a human flyer is better fitted than the most sensitive instrument.

In addition, we have the possibility of incorporating techniques for recovery and reuse into our booster systems. This will make possible a very substantial saving in cost. There still remains a great deal of development work to be accomplished. However, our studies convince us that such a system is both technically feasible and operationally desirable.

Our program today and our needs for the future present challenging objectives, and there are always skeptics and doubting Thomases, who will question their attainability. Had the kind of thinking represented by the skeptics and doubters prevailed in 1954, we would not have an ICBM today. None of the ICBM subsystems existed at that time—in fact much of the ICBM system had not advanced beyond theory. It is fortunate that the believers with faith prevailed in this instance.

History unfortunately more often reveals the opposite story to be the case. It certainly was so in the case of the airplane. The examples are too numerous to mention. This was no one individual's fault. It was just a fact that in the prenuclear rocket era, there was a lack of interest in pushing technology, which possessed primarily a military potential. Certainly our efforts in research and development during this time period were not keyed to the issue of national survival. Nor was this necessary. Likewise our potential enemies were not any more imaginative than we in carrying their research and development efforts into operationally ready weapon systems.

We were therefore able to rely upon our geographical position to give us needed time to mobilize our economic and productive strength. These were strengths which when equated to quantity in both World Wars I and II never left the issue in doubt. This fortunate circumstance of time to mobilize after the outbreak of hostilities no longer exists.

In the future, if we are to hold the lead in development, a lead which is essential to survival of the western world, it will be necessary that we somehow exploit much more rapidly the potential advances of technology. Faced by an aggressive Communist state which is carrying out a planned exploitation of science, we can no longer wait for things to evolve just naturally. We must search out ways of applying the free enterprise system to the rapid exploitation of new possibilities. We must somehow analyze the problems that face us and determine the direction which it appears most promising to proceed.

In closing, I am confident that the combination of imagination, objectivity, and competence is available and can be applied to the problems of military superiority in the space age. The objectives which I have mentioned I think can be attained, and there is a high probability that they can be attained in this decade. Our development activities and advanced studies definitely indicate a high degree of technical feasibility in all areas. Successful achievement of even the larger part of these objectives can make possible many new applications of space for the strengthening of our strategic posture and for the maintenance of peace. There has never been a more important time for doing than now.

AGREES THAT MILITARY SATELLITE PROGRAMS ARE BEING PACED PRIMARILY BY TECHNOLOGICAL LIMITATIONS

Mr. LEHRER. I believe you were here, General Schriever, when Dr. York testified with regard to some of the statements made by General Betts. You recall that with respect to Samos, Transit, Tiros, and Midas, General Betts has said—

In the judgment of many, they are being paced only by technological limitations, not by the availability of funds.

Dr. York was questioned on this, and indicated that he would change the word "only," to "primarily."

Now, with respect to the two programs which are the responsibility of the Air Force, namely, Samos, and Midas, would you tell this committee whether you believe that these programs are being paced either "only" by technological limitations, or "primarily" by technological limitations, and not by availability of funds?

General SCHRIEVER. Well, I would agree with Dr. York, that "primarily" is correct, and this relates to the development program. And

I am talking now about the stepped-up Midas, which has occurred here in the past few weeks. I have forgotten exactly when this decision was made, but it has been only recently.

WE SHOULD BROADEN OUR OBJECTIVE TO ACHIEVE EARLIEST OPERATIONAL CAPABILITY

I feel that in my own opinion our objective should be broadened to achieve the earliest operational capability that technology will permit, and I think if you were to apply that objective to those two programs, then there would probably be different judgments as to when that earliest capability can be attained. Of course, my recommendations, that is the Air Research and Development Command's recommendations, which have been passed on to DOD, recommended a very tight schedule here. There are judgments that we cannot meet some of these objectives.

WE SHOULD CARRY OUT DEVELOPMENT PROGRAMS UNDER A CONCEPT OF CONCURRENCY

Mr. LEHRER. You have testified several times to other committees, that high priority weapons systems of the future, which promise technological or operational breakthroughs, should be initiated on the basis of technical feasibility, and carried out under a concept of concurrency. Have you altered your views on this subject at all, and if not, would you outline what you mean by initiating these programs on the basis of technical feasibility and carrying them out under a concept of concurrency?

General SCHRIEVER. Yes. I have not altered by view on this at all. We are in fact in the Defense Department doing just that in our ballistic missile programs which include also the Polaris program, as well as the Air Force Ballistic Missile programs. What I mean here is that you start out first by applying the very best judgment as to when you can develop a particular weapons system so that it will have a degree of reliability which is adequate for operational use, and will do the things that you are asking it to do performancewise, so that the development timetable is the pacing item.

Of course, you establish an estimated cost of this development program, and all the resources that are required to do it.

But then, to put it into operational use at the time that it reaches this particular objective, reliability and performancewise, you have to start with long leadtime items that relate to personnel training, that relate to operational bases, that relate to logistic support. And these things have leadtimes very often that are considerable.

The Navy, for example, has a long leadtime in their submarines. We have a long leadtime in building our operational bases, establishing our training facilities, and training the people, organizing the units.

In the satellite field, a satellite is no good just floating around the earth in orbit unless you have ground stations to go with it that take the information and data from the satellite and pipe it into the necessary operational commands that will use it.

So when I am talking about an operational system, I am talking about ground stations, personnel trained to operate these ground sta-

tions, the development of the facilities, and instrumentation that goes with it.

I am not talking about research development instrumentation, rangewise. I am talking about operational facilities.

DISAGREES WITH GENERAL BETTS ON COMMUNICATIONS SATELLITE

Mr. LEHRER. Do you, then, agree with General Betts when he said, with reference to the communications satellite:

We could crash this effort and fly some kind of a real time repeater satellite in a year or so. It would provide some additional communications channels for a limited time, no doubt about it, but without reliable components operating in the best frequencies, it would just not make sense to pour operational money into such a rathole at this time.

General SCHRIEVER. Well, I have a lot of respect for General Betts, but I don't agree with that. He is basing it on reliable components. It is a matter of judgment. I think you have to—you can test components on the ground until you are blue in the face. You have to start flying them to determine how reliably they will operate. You can make all kinds of studies on how long something will work.

I think that Pioneer V, the solar batteries on Pioneer V are an example; you have to start doing things.

In the ballistic missile program, our computers for our guidance systems, we couldn't get a reliable diode or transitor. But if we had not pushed, and pushed hard, it would have taken us maybe 6 or 7 years to do it. Instead we did it in 3. It is a matter of attitude, I think. And it is how hard you want to do something.

Mr. LEHRER. And of course how much you are willing to pay.

General SCHRIEVER. That is right.

OUR DECISION MAKING PROCESS HAS TO BE SPEEDED UP

Mr. LEHRER. Do you believe, particularly from the viewpoint of SAC's requirements, that we should be doing more in developing the communications satellite as an operating system?

General SCHRIEVER. There has been considerable study, as Dr. York pointed out, as to the 24-hour satellite, and then a lower altitude satellite for SAC.

I don't wish to comment on that. I think SAC is one of the important users of fast communications. But the whole decision-making process in this country has to be speeded up in the nuclear rocket age. And I feel that we should go just as rapidly as we can, with the communications satellite program.

And I am talking primarily in terms of the 24-hour satellite.

PROJECT DROMEDARY IS UNDER DEVELOPMENT

Mr. LEHRER. Now, a member of the Rand Corp. has been quoted as revealing that the Air Force is considering developing a flying equivalent to the Polaris submarine for airborne alert operations, called Project Dromedary. What can you tell us about this, in open session?

General SCHRIEVER. Not a great deal. We have had under study, Rand has had under study, a program, or projects of long endurance type aircraft. We still have these under study. The state of the

art in chemical propulsion, turboprops, turbo fans, the possibility of the use of boundary layer control, and things of that kind, lend some promise to building a long endurance type airplane. It could be used as an airborne command station.

NAVY REPORTED DARK SATELLITE PROMPTLY TO PROPER AGENCY

Mr. LEHRER. General, as you know, there were quite a few stories published alleging that the Navy neglected to notify the Air Force on a timely basis of the discovery of the so-called dark satellite. Is there any basis for that, and if so, what has been done to prevent a repetition of this in the future?

General SCHRIEVER. I don't believe there is. I don't have all the details, but to the best of my knowledge, when the Navy determined that they had something of an unknown type, they immediately did report it to the proper intelligence agency here in Washington, who in turn reported it to the Spacetrack up in Cambridge, who then picked it up within a matter of hours.

I have had several discussions with Admiral Hayward on the whole problem of Spacetrack and working very closely together with the Navy. We have a working group on this right now.

I would say, without a question, there was nothing deliberate in this, and I am sure of it. In any way.

Mr. LEHRER. Would you provide an amplified statement on this for the record, General?

General SCHRIEVER. I will, because I am a little bit hazy on the details.

(The information is as follows:)

(1) In response to your request for an amplified statement for the record concerning the discovery of the dark satellite, I can say I have looked into the details thoroughly. In my opinion there is no basis for allegation of delay in notifying the Air Force on a timely basis. The facts of the case are that on February 2, the Air Force was notified of the space object. The Navy had detected the passage on four different occasions, two on the 31st of January and two on the 1st of February, of an object which appeared to be an unidentified earth satellite. It must be borne in mind that the observation systems are triggered each day by meteorites and other natural phenomena as well as by earth satellites. Identification is just one of the problems we face in this area, but it is one of significance in the subject under question. As the state of the art improves, the detection and identification time will shorten.

(2) Acting upon the information provided, the NSSCC sighted the object within a few hours after notification. Estimating the orbit from minimal data and searching and tracking the satellite is a truly outstanding feat. It is a monument to the skill and experience of the scientific and technical personnel involved. Continued evaluation of space tracking data from all sources brought the tentative conclusion on February 19, that the object could be the capsule of Discoverer V. On February 24, the announcement was made by NSSCC that in their considered opinion the earth satellite vehicle is the capsule of Discoverer V.

(3) My discussion with Admiral Hayward on the problem of Spacetrack, and the group we have working on this, reflect the degree of importance and accord we have on this subject. The relationship between the services is good and improving. Our proposed exchange of liaison officers is but one step in this direction.

PROBLEM OF OVERFLIGHTS OVER POINT ARGUELLO HAS BEEN SOLVED

Mr. LEHRER. Fine. Now, one other problem of coordination has been rather evident, and that is the question of coordination of the

various missile ranges, and particularly the activities on the west coast of the Pacific Missile Range.

What can you tell us about that, and about what the Cisler committee is doing after having looked into this problem?

General SCHRIEVER. Well, I think with respect to the Cisler committee, it would have been better to ask Dr. York. Maybe you did. We have not gotten a decision out of the Department of Defense, at least not to my knowledge. I have been gone for a week or so. Our relationship with PMR on the west coast is very good. I have a field office, stationed at Vandenberg Air Force Base, which is responsible for the launch of the research and development type vehicle, such as Discoverer. We work with the Pacific Missile Range directly in this. I certainly don't want to leave the impression that there have not been some procedural problems there, because it is only natural that you would have—if you have a research and development range adjacent to a base which is primarily operational and training, you will have some overlap which has to be taken care of procedurally. I think that for the most part, this has been done. The latest Burke-LeMay agreement I think is being carried out, not only in the letter, but in the spirit, and I don't know of any problems out there at the moment.

Mr. LEHRER. General, on visiting both of the installations involved, we found that there still appeared to be a rather marked difference of opinion regarding overflights of missiles launched from Vandenburg Air Force Base over Point Aguello.

General SCHRIEVER. When was that?

Mr. LEHRER. In November and December of this past year.

General SCHRIEVER. At that time that was true. Since that time we have reached complete agreement. As a matter of fact, our Discoverer flights are even a little bit more—the trajectory is a little bit more to the left. And there is complete agreement now with PMR, and PMR operates the range safety at the present time.

Mr. LEHRER. Again, for the record, could you provide us with a detailed statement, coordinated with the Navy, that will treat the subject and indicate the manner in which the problem has been solved?

General SCHRIEVER. All right. You are talking now about the overflights?

Mr. LEHRER. The question of overflights specifically.

General SCHRIEVER. All right. Glad to do that.

(The information is as follows:)

In response to your request for a statement coordinated with the Navy on the problem of overflights over Point Arguello, the following direct quote from the USAF/Navy agreement is submitted. This agreement was signed on March 24, 1960 by representatives of the USAF and Navy, PMR.

"AGREEMENT BETWEEN PACIFIC MISSILE RANGE, 1ST MISSILE DIVISION, AND AIR MATERIEL COMMAND/SBAMA FOR THE TRANSFER AND MAINTENANCE OF MISSILE FLIGHT SAFETY EQUIPMENT AND USE OF FACILITIES

"1. PURPOSE

"The purpose of this agreement is to set forth the policy and procedures for the transfer to and maintenance of missile flight safety equipment and use of facilities at Vandenberg AFB by the Pacific Missile Range. Further, this agreement describes the areas of responsibility and provides for the orderly transfer of equipment and spares to be completed by June 1, 1960.

"2. REFERENCES

"It is mutually agreed that this document is in consonance with the agreement for coordinated peacetime operation of the Pacific Missile Range as approved by the Vice Chief of Staff, U.S. Air Force, and the Chief of Naval Operations on September 22, 1959.

"3. CONCEPT OF OPERATION

"Two categories of launches to be conducted in the Vandenberg/Arguello area can be defined as follows:

"A. Ballistic missiles launched from the Vandenberg area required in the training of ballistic missile operational units. For these launches, the Pacific Missile Range will provide missile flight safety facilities to monitor the missile's progress. The 1st Missile Division, missile flight safety officer, will be responsible for implementing range safety procedures and, when required for safety purposes, destroying the missiles.

"B. All other missiles, satellites, and space vehicle launches from the Vandenberg/Arguello area by the Air Force. For these launches, the Pacific Missile Range will provide and operate missile flight safety facilities and have responsibility for destruct action when required.

"4. RESPONSIBILITIES

"A. Pacific Missile Range will:

"1. Provide all missile flight safety equipment, on a nonreimbursable basis, from which the missile flight can be monitored, and from which the missile can be destroyed in flight if necessary.

"2. Program, fund, install, and operate, on a nonreimbursable basis, any additional missile flight safety equipment required to support Air Force launches.

"3. Provide maintenance support of the missile flight safety equipment and associated test equipment when transferred to the Pacific Missile Range.

"4. In accordance with the schedule contained in paragraph 9 below, provide qualified missile flight safety officers to activate inflight destruct devices for launches described in paragraph 3B above, and provide necessary support in those associated fields to cover paragraph 3A above.

"5. Fund for all range safety interconnecting communications circuitry and subscriber equipment beyond that now programed by AFBMD through fiscal year 1960.

"6. Place quantitative requirements and qualitative criteria to meet all followon range safety communications demands.

"7. Program and found for construction, conversion, alteration, or modification of missile flight safety facilities at Vandenberg Air Force Base.

"8. Provide a monitor during the installation and check out of the airborne missile destruct system for all missiles specified in paragraph 3B. This monitor will report directly to the responsible missile flight safety officer as to the status and final verification of the airborne missile destruct system.

"B. The Air Force will:

"1. Provide qualified missile flight safety officers to activate inflight destruction devices for launches described in paragraph 3A above. These officers will be assigned to 1st Missile Division, with duty at naval missile facility, Point Arguello, as determined by 1st Missile Division.

"2. Install, check out, validate, and maintain components of the missile-borne flight safety system for all Air Force launches from Vandenberg/Arguello.

"3. Operate and maintain the operation and checkout (O. & C.) blockhouse console during required operations in support of all Air Force launches from Vandenberg/Arguello. These operations include missile system verification tests, static firings, and missile launch operations.

"4. Connect and disconnect missile-destruct system ordnance in support of all Air Force launches from Vandenberg/Arguello.

"5. In accordance with AFR 172-5/Secnavinst 7100, construct, convert, alter, modify, and maintain flight safety facilities at Vandenberg. Also, provide fire protection and refuse collection and disposal.

"6. Make all cable assignments for cable pairs terminating on Vandenberg AFB and provide all maintenance surveillance and scheduling.

"7. Provide centralized control of all communications facilities on Vandenberg AFB by means of the established control office CISCO.
"8. Fulfill range safety requirements and communication requirements from existing capability whenever possible.
"9. Operate the VAFB COTAR fields until June 1, 1960.

"5. OPERATIONS, COMMUNICATIONS, AND SAFETY

"A. The concepts and procedures associated with these activities will be determined by the following committees and subcommittees as established in the 1st Missile Division, Pacific Missile Range bilateral agreement.
"1. Procedural Policy Committee.
"2. Communications subcommittee.
"3. Frequency interference coordinating subcommittee.
"4. Range scheduling subcommittee.
"5. Safety and traffic control subcommittee."

The above agreement provides that the PMR is responsible for overflight and range safety on all missiles other than ballistic missiles required in the training of the ballistic missile operational units and for all other missiles, satellites, and space vehicle launchings from the Vandenberg-Arguello area by the Air Force. For these launchings, the PMR will provide and operate missile flight safety facilities and have responsibility for "destruct" action when required. I believe that this agreement will insure a coordinated solution to the overflight problem.

ADDITIONAL MONEY IS TO BE SPENT ON MINUTEMAN DESPITE SECRETARY GATES' TESTIMONY TO THE CONTRARY

Mr. LEHRER. I have one final question.

When Secretary Gates testified before the joint hearing of the Preparedness Investigating Subcommittee, and the Committee on Aeronautical and Space Sciences, he was asked by Senator Jackson as follows:

Now, what about the Minuteman program? Do you feel that additional funds would speed the time when we would achieve what I think is one of the finest deterrent systems that has a sizable capability?

Secretary Gates responded:

Up until now, with constant urging, too, I have been advised that there is no way we can usefully spend any additional money on the Minuteman to accelerate its procurement and placement in operational status. I have asked this question, and I received that answer repeatedly.

Now, according to the recent stories of General White's testimony on revised plans for fiscal year 1961, as presented to the Appropriations Committee, and as released by the Pentagon, apparently it is now proposed to spend additional money on the Minuteman.

Could you explain this anomaly?

General SCHRIEVER. Yes, I think I can, although I do not have all of the details with me today and I don't know exactly what General White has reference to. We have always received from the Department of Defense approval of everything we have asked for in terms of funds for the Minuteman program. The Minuteman program has been on a highly accelerated basis for the past year, and I know that we cannot accelerate it any further in terms of the operational dates—not with money.

Now, we have introduced, however, during the past year, the mobile Minuteman system, which we had under study prior to that time, but we had not made a part of the program. I cannot at this time give you the exact date that it was introduced.

We have found that our costs with respect to this part of the program are somewhat higher than we had anticipated, primarily due to the inception of the mobile version. And furthermore, we have found that we could accelerate this portion a little bit. This was done within the Air Force.

So we are attempting to accelerate this portion of the overall program, and I believe that this must have been what General White had reference to. Therefore some additional funds are required here.

Mr. LEHRER. Well, there still seems to be a contradiction in timing, since Secretary Gates testified on the 16th of March.

General SCHRIEVER. Well, I think this, the Air Force has not received approval from the Department of Defense of the additional requirements mentioned by General White. This was internal Air Force reprograming, or consideration of reprograming.

We have not actually done it yet. In other words, the money has not been placed on it. This is a contemplated plan.

Mr. LEHRER. So that you do not have Secretary of Defense approval to proceed with the augmented Atlas program, or to spend more money for Minuteman, or the other program increases mentioned in General White's testimony, as an offset to the cutback in Bomarc, is that correct?

General SCHRIEVER. I cannot answer that, because I don't know exactly what has been presented to the Department of Defense on this. But in fairness to the Department of Defense, they have given us every nickel we ever asked for for the Minuteman program.

Mr. LEHRER. I would like to ask you on behalf of the committee, General Schriever, to look into this situation, and please provide a statement for the record that would indicate the timing involved in the decision to spend more money for Minuteman, and exactly what that will do—whether it will in fact accelerate the program, or merely meet cost overruns.

(The information is as follows:)

As indicated in my testimony, I was not familiar with the details of the Air Force Air Defense reprograming proposals. Since that time, however, I have ascertained the following:

With respect to Air Force reprograming in the Air Defense area as pointed out by General White at the time he presented it to the House Appropriations DOD Subcommittee, the reductions and cutbacks in the Air Defense program had been approved by the Department of Defense. However, the augmentations in various programs such as the Atlas and Minuteman had not been reviewed in detail although they had been approved for presentation.

With respect to the augmentation of the Minuteman program, at the time Secretary Gates last reviewed the program he did request an indication as to whether additional funds would accelerate the program with a view toward advancing operational dates. At that time the Air Force stated that funds could not accelerate the operational dates established for the Minuteman and that the Minuteman development program leading to the present operational dates was most stringent. Since Mr. Gates' review, the Air Force Ballistic Missile Division has been undergoing their annual contractor financial review, which usually begins late in February and ends late in March. This review revealed that the minimum amounts placed in the fiscal year 1961 budget for the mobile Minuteman during last fall, which at that time were contractors' best estimates would have to be augmented in order to preclude disruptions of the already tight development program tied to the initial operational dates. It is understandable that the amounts contained in the fiscal year 1961 budget estimate which was prepared in the fall of last year would represent the most accurate estimates based on the details available at that time. Subsequently, after reviewing complete

details of the various research and development tasks and projects, engineering effort required and component testing necessary for this type of technical program, it was ascertained that the magnitude of the program was greater than originally anticipated.

Senator YOUNG. General Schriever, it has been a pleasure to have you here today. As usual, you have been a very outstanding and forthright witness. Since there are no further questions, the subcommittee is recessed, subject to the call of the Chair.

(Whereupon, at 1:10 p.m., the committee was recessed, subject to the call of the Chair.)

* * * * * * *

(Chart 66, referred to on p. 137, appears here:)

CHART 66

FISCAL YEAR 1961 ESTIMATES

PLANNED DISTRIBUTION OF EFFORT FOR RESEARCH CENTERS

PROGRAM AREA	PROFESSIONAL PERSONNEL	SALARIES & EXPENSES (MILLIONS OF DOLLARS)
Hypersonic Aerodynamics	305	10.21
Flight Mechanics	258	10.87
Chemical Rockets Research	239	6.91
Materials Research	221	7.30
Structures Research	192	4.90
Supersonic Aerodynamics	184	9.46
Operational Problems	148	5.98
Instrumentation and Data Acquisition Research	112	5.01
Nuclear Rockets Research	107	3.84
Subsonic Aerodynamics	98	2.36
Jet Engine Research	62	2.13
Electrical Rockets Research	58	2.82
Power Generation Research	47	2.15
TOTALS	2031	73.94

60-1006

* * * * * * *

SELECT QUOTATIONS FROM THE WESTERN EUROPEAN PRESS

The following quotations, referred to by Dr. Glennan on page 64, were furnished to the committee by the National Aeronautics and Space Administration.

The set of quotations compiled by NASA on December 23, 1959, followed the successful launchings of the Soviet Lunik II lunar probe and Lunik III translunar satellite.

The set of quotations dated March 31, 1960, followed the successful U.S. launching of the Pioneer V solar satellite.

SELECT WESTERN EUROPEAN PRESS QUOTATIONS ON U.S.-U.S.S.R. OUTER SPACE RACE

(December 23, 1959)

Austria

"The launching of Sputnik less than 2 years ago caused the Americans to awake from a kind of 'sleeping beauty' slumber and accelerate their own programs—even though by far not yet as intensively as they had done with certain military programs during the Second World War. Instead of creating a defeatist hysteria in the United States, Khrushchev could thus well cause the Americans to multiply their own efforts * * *. No matter how wonderful it is to send a missile to the moon, it is of little comfort to the peoples of the world. For the problems of the freedom of the West Berliners, hunger in Asia, and threat of war in the jungle of Laos are not being solved on the moon" (Vienna's Die Presse, Sept. 15, 1959).

Britain

"Mr. Khrushchev now commands rocketry that is not only powerful to the *n*th degree, but also reliable * * *" (Daily Telegraph, Sept. 14, 1959).

"Indeed, it may be doubted whether Mr. Khrushchev, accorded full honors as a head of state, would now be leaving for Washington had not the first sputnik 2 years ago shocked the United States into a dire, if grudging, admission that Russia, in some respects, held a commanding lead in the conquest of space" (Times, Sept. 14, 1959).

"[The Soviets] have proved themselves the Columbuses of the space age * * * they deserve to be congratulated * * * but * * * the rocket has political as well as scientific implications. The timing * * * was designed to make it clear that Mr. Khrushchev is talking from strength, not weakness * * *. The Russians have gained such a tremendous prestige advantage they can afford to be generous" (Guardian, Sept. 15, 1959).

"In putting a space vehicle onto the moon the Russians have provided the most complete, as well as the most dramatic, proof of the length of the lead they now hold in accuracy of launching and control. The rocket, in Soviet hands, has become a precision instrument" (Times, Sept. 15, 1959).

Denmark

"The event has released a new sensation: the satellite was guided almost all the way. * * * The hammer and sickle have been planted on the moon as a visible manifestation of the fantastic Russian space victory" (Copenhagen's Berlingske Tidende, Sept. 14, 1959).

"* * * the first atomic conference in Geneva was arranged on American initiative, at a time when the U.S.A. was unconditionally the dominating atom power. In the same way, the Soviet Union has, by taking the initiative now (in calling for an international conference on outer space) reminded the world of the fact that it is Moscow who has penetrated deepest into outer space, and probably has most to give * * *" (Copenhagen's Politiken, Oct. 8, 1959).

"Certainly, the moon rocket has hardly changed the military situation entirely, but the peril of a real race in outer space is threatening. * * * The moon achievement has been utilized in a great Communist propaganda for the superiority of the Soviet system. * * * We must assume, however, that millions of Soviet citizens are more interested in the conditions on the earth than * * * on the moon" (Copenhagen's Aktuelt, Sept. 16, 1959).

"One may say that one should not be surprised, either because the moon was reached or because the Russians came first. * * * But * * * it makes a difference that it has, in fact, taken place * * * every little human being, in the very instant when the Soviet ruler sets his foot on American soil, must have told himself that now we know * * * that a H-bomb-carrying rocket can, with precision, hit New York * * *" (Copenhagen's Information, Sept. 14, 1959).

France

"This is the triumph of a genius guidance system. Another factor of which the Soviets can be proud is that the operation could be carried out on a definite date: at the very moment when such news would act with maximum emotional power, on the eve of Khrushchev's departure for the United States" (Le Parisien Libere, in September 1959).

"It is with the purpose of putting all the trump cards on his side in his secret ambitions that Khrushchev sent the new rocket to the Moon over the weekend. It is to make it quite clear to the Americans that he is not the representative of

a backward country but of a power at least equal to the United States that Khrushchev staged the successful lunar shot" (Paris-Journal, Sept. 14, 1959).

Germany (West)

"Experts assure us that the U.S. guided missile program is making extraordinarily satisfactory progress. * * * On earth or below the surface of the ocean, the U.S. arms technology has not been surpassed by that of the Soviet Union at all. On the contrary * * * such things count more than the sensation-success of one moonshot" (Cologne's Welt de Arbeit, Sept. 18, 1959).

"If we had to choose between freedom and moon rocket, we would choose freedom. However, we need not make such a choice because the United States will accomplish a moonshot tomorrow or the day after. As far as the military balance of power is concerned, lunik is not decisive in the close race between two world powers" (Berliner Morgenpost, Sept. 14, 1959).

"To launch a moon rocket 3 days before Khrushchev's America journey is, of course, transparent propaganda. * * * We must nevertheless not forget that a highly developed technology—and especially the rocket technology—constitutes political power today. This is the serious background of the playful flight to the moon. The Soviet headstart is not great in this head-on-head race; yet, Khrushchev will know how to exploit it in his talks with Eisenhower" (Dortmund's Westfaelische Rundschau, Sept. 14, 1959).

Italy

"The Soviet Union has certainly made gains, and now (with the moonshot) it has achieved an historic landmark, but this is of limited importance in the matter of technical military progress. Actually, each of the contenders possesses the destructive potential to annihilate himself as well as his adversary" (Rome's Il Piccolo, Sept. 15, 1959).

"It is clear that the country that can hit the moon with a rocket may more easily drop an H-bomb on New York or San Francisco. Now the Russians as well as the Americans possess the weapon of terror. Nuclear war would mean the end of everyone and everything" (Milan's La Stampa, Nov. 3, 1959).

"The latest moonshot * * * frightens no one and * * * does not alter the political balance between the two coalitions" (Rome's Il Tempo).

Sweden

"The Soviet triumph should not be overestimated, even though the Russian scientists have apparently solved the formidable problems of guiding rockets through space. There can be no doubt that man's conquest of the nearest celestial bodies has not gone far enough. In terms of astronomical distances, he is still fussing in his own backyard" (Stockholm's Svenska Dagbladet, Oct. 6, 1959).

SELECT QUOTATIONS FROM THE WEST EUROPEAN PRESS CONCERNING THE U.S.-U.S.S.R. OUTER SPACE RACE AFTER PIONEER V LAUNCHING

(March 31, 1960)

Britain

"This is America's second successful [solar] space launching to brighten a long list of frustrating failures—and it represents a new challenge to the Russians" (London's Daily Express, Mar. 12, 1960).

"The value of information will be much increased if its [Pioneer V] ambitious arrangements for the storage of information and its transmission back to Earth are successful. This will be as important an innovation in its way as the Russian technique of developing negatives in flight and later transmitting them slowly by radio" (The Times, London, Mar. 12, 1960).

"The package of instruments—the most compact and complex ever designed—is a real triumph for American technology. And for rocketry and instruments Pioneer V ranks with Russia's Lunik III, which photographed the unseen side of the Moon" (News Chronicle, London, Mar. 12, 1960).

Denmark

"With the successful launching of the satellite Pioneer V yesterday, the Americans accomplished the world's most important space experiment so far and gained considerably upon the Soviet Union in the space race. The American experiment will have greater meaning for science [than the Russian moonshot] and is the real forerunner of space travel" (Berlingske Tidende, Copenhagen, Mar. 12, 1960).

"It would be wrong to consider this event as an American attempt to overcome an inferiority complex and an experiment to match the Soviet triumph in the skies. First and foremost, the experiment serves scientific purposes. The American scientists have with this satellite provided a fairly clear picture of conditions in space" (Information, Copenhagen, Mar. 12–13, 1960).

France

"The Americans can give the Russians change for their coin [give better than they received] with the remarkably successful launching of Pioneer V" (Parisien Libere, Paris, Mar. 16, 1960).

"Pioneer V will probe the unknown regions of the sky. It will speak to the Earth from a distance of 80 million kilometers while Lunik I went dead at 600,000 kilometers" (France-Soir, Paris, Mar. 13–14, 1960).

"American scientists can rejoice at the success of this launching" (L'Aurore, Paris, Mar. 15, 1960).

"Lunik I has not done this [radioing back from the apogee]. It was silent. Pioneer V will bring us information of the highest importance" (Combat, Paris, Mar. 16, 1960).

Germany (West)

"After a series of Soviet triumphs and a chain of discouraging [United States] failures, the successful launching of Pioneer V is a ray of hope not only for the United States but for the entire West" (Die Welt, Hamburg, Mar. 14, 1960).

"It is a fact that the Soviet moonshot yielded, at best, a hundredth of the scientific data the new U.S. space probe is capable of transmitting * * * back to Earth" (Muenchener Merkur, Munich, Mar. 14, 1960).

"Although Pioneer V weighs only one-ninth as much as Lunik I its significance in space exploration is much greater" (Der Mittag, Düsseldorf, Mar. 14, 1960).

"Of the three artificial planets in orbit around the sun, two are American made * * * American satisfaction is natural at a time when national prestige is dependent on launching moon rockets and sun planets" (Frankfurter Rundschau, Frankfurt, Mar. 14, 1960).

Italy

"Today's success helps to restore, at least in part, the prestige of American science and technology after last year's spectacular Soviet experiment" (Il Messagero, Rome, Mar. 12, 1960).

"While Pioneer V cannot be compared to Soviet ballistic successes, it is nevertheless the first 'planet' capable of transmitting scientific information to Earth * * * Lunik I entered a solar orbit by error and was not equipped to send back information" (La Stampa, Turin, Mar. 13, 1960).

"The successful launching [of Pioneer V] is a tonic for the United States in the Russo-American space race and confirms that although the United States got a late start, it is very rapidly regaining lost ground" (Corriere della Sera, Milan, Mar. 13, 1960).

Norway

"It is certainly the greatest distance of space control by radio signal. The distance from the earth of the Soviet Lunik III was around 100,000 kilometers less. The successful launching of Pioneer V is truly a forerunner of a new American scientific attempt to send a rocket to the moon within the next 6 months" (Arbeiterbladet, Oslo, Mar. 14, 1960).

Sweden

"Pioneer V opens a new epoch in space experiment" (Dagens Nyheter, Stockholm, Mar. 12, 1960).

* * * * * * *

(Mr. Horner's letter to the Air Force, referred to on p. 369, is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
April 1, 1960.

Hon. JOSEPH V. CHARYK,
Under Secretary of the Air Force,
Department of Defense,
Washington, D.C.

DEAR DR. CHARYK: As a result of informal discussions, we have established a practice of incrementally funding those boosters which we have bought from the Atlas and Thor programs.

The question has now been raised as to whether or not the recent decision of the Department of Defense to fully fund the procurement of Atlas missiles will change your requirements upon us for advanced funding. Both our current year program and our proposed fiscal year 1961 budget are formed on the basis of incremental funding. We would therefore find it difficult to modify our approach in this time period, but if necessary we could, of course, make provisions in our fiscal year 1962 budget cycle.

The NASA Authorization Subcommittee of the Senate Committee on Aeronautical and Space Sciences has asked us to provide evidence of our understanding with the Department of Defense. I would therefore appreciate a reply that could serve that purpose.

Sincerely yours,

RICHARD E. HORNER,
Associate Administrator.

* * * * * * *

(This additional statement concerning priorities, discussed on pp. 35–36, was subsequently submitted by Dr. Glennan:)

On October 14, 1959, a letter was received by NASA from the Office of the Assistant Secretary of Defense (Supply and Logistics), which invited NASA to submit nominations for the Department of Defense master urgency list for calendar year 1959. In response, on November 14, 1958, NASA requested that two projects, the manned satellite and the 1½ million pound thrust engine, be placed in the brick bat 0.01 category of the Department of Defense master urgency list. The brick bat 0.01 category in the master urgency list corresponds to the DX category in the industrial priority system established under the Defense Production Act.

Subsequently, on December 3, 1958, NASA reported the request referred to above to the President and the National Aeronautics and Space Council. As an outcome of the discussion which followed the report of NASA's request to the Department of Defense, it was mutually agreed and decided not to pursue the NASA request for the 0.01 priority on the projects until they could be closely monitored by both NASA and the Department of Defense to determine if any delays were encountered in either program which could be attributed to the lack of a 0.01 or DX priority. It was further agreed that additions to the DX category should be made only where delays were beginning to develop in order to minimize the dilution of the effectiveness of that list. In the meantime, the Secretary of Defense offered expediting assistance to avoid any particular bottlenecks which might develop.

During the next 3 months both programs were treated as high priority within NASA and the Department of Defense and closely scrutinized to determine whether any delays were attributable to difficulties in the allocation of materials or coordination of industrial facilities. At no time during this period was there any evidence that delays were due to the lack of a DX priority; however, in March evidence begun to accumulate pointing to a need for the higher priority on the manned satellite program if material and equipment supply difficulties were to be avoided. There was not at that time, nor is there now, evidence that the 1500K engine project has been delayed by the lack of highest national priority.

Subsequently, with the support of the Department of Defense NASA initiated a request for a DX priority on Project Mercury to the President. The President approved the DX priority for Project Mercury on April 27, 1959.

Following this notification, the President's decision was sent to appropriate parties on April 30, 1959. On May 4, 1959, NASA was informed by DOD that the manned satellite program was listed in the DOD master urgency list as having a "brick bat 0.01" priority rating.

It should be noted that neither project was ever rejected for a DX priority rating or for inclusion in the 0.01 priority category of the master urgency list. Rather, as I have noted above, a period of close monitoring of possible delays was agreed desirable to validate the real need for the DX priority rating.

As NASA officials have assured the committee in the past, when evidence appears that significant industrial production problems are identified as resulting from difficulties in acquiring material, equipment, or industrial support, the question of a DX priority for the 1500K engine project and the justification for the priority will be taken up with the President.

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